1210

RANDOM VIBRATION CONTROLLER

OPERATING MANUAL

Solartron Instruments

MP MASTER
MA20210
SOLARTRON
Schlumberger

1210 Random Vibration Controller

Operating Manual

Issue 2: August 1983

Part No 12100006

SOLARTRON
Schlumberger

Solartron Instrumentation Group.
Victoria Road Farnborough Hampshire England GU14 7PW
Telephone: Farnborough (0252) 544433 Telex: 858245 Solfar G
Cables: Solartron Farnborough
A division of Schlumberger Electronics (UK) Ltd.

Solartron pursue a policy of continuous development and product improvement.
The specification in this document thus may be changed without notice.

Contents

			Page
Chapter 1	**RVC Capability**		
	1.1	Introduction	1.1
	1.2	Power-up State	1.1
	1.3	Control Keyswitch	1.2
	1.4	Manual Control	1.2
	1.5	Display	1.2
	1.6	Battery Sustained Store	1.2
	1.7	RVC Design Standard	1.2
	1.8	RVC Specification	1.3
Chapter 2	**Operating Procedure**		
	2.1	Closed Loop Control	2.1
		2.1.1 Status	2.1
		2.1.2 Test Number	2.1
		2.1.3 Input Configuration	2.3
		2.1.4 Drive Calibration	2.4
		2.1.5 Analysis Configuration	2.4
		2.1.6 Display	2.5
		2.1.7 Demand Spectrum Profile	2.6
		2.1.8 Demand grms Levels	2.8
		2.1.9 Protect Limits	2.9
		2.1.10 Drive Limits	2.10
		2.1.11 Closed Loop Operation	2.11
	2.2	Analysis Mode	2.14
Chapter 3	**Front Panel Key Functions**		
	3.1	Power Switch	3.1
	3.2	Brilliance and Contrast	3.1
	3.3	Main Keyboard and Softkeys	3.1
	3.4	Closed Loop, Open Loop and Calibrate Modes	3.3
		3.4.1 ANALYSE	3.3
		3.4.2 RUN LOW	3.3
		3.4.3 RUN HIGH	3.4
		3.4.4 HOLD	3.4
		3.4.5 ABORT	3.4
		3.4.6 CALIBRATE	3.4
	3.5	Analysis Keys	3.7
		3.5.1 SET INPUT	3.7
		3.5.2 SET DRIVE	3.7
		3.5.3 SET ANALYSIS	3.7
	3.6	Program Keys	3.8
		3.6.1 TEST NUMBER	3.8
		3.6.2 DEMAND PSD	3.9
		3.6.3 LEVEL SEQUENCE	3.10
		3.6.4 PROTECT LIMITS	3.11
		3.6.5 DRIVE LIMITS	3.11

3.7 Display and Cursor Controls 3.12
3.7.1 MAIN 3.13
3.7.2 OVERLAY 3.14
3.7.3 SCALE 3.14
3.7.4 FREEZE 3.15
3.7.5 PLOT 3.15
3.7.6 Cursor and Graticule 3.16
3.7.7 STATUS 3.17
3.7.8 Display Status Lines 3.18
3.8 Numeric Entry 3.19
3.9 Self Test 3.20
3.10 rtl (return to local) 3.20
3.11 Control Keyswitch 3.20
3.12 Interlock 3.21
3.13 Operator Messages 3.23
3.14 Recovery from Failure to Equalise 3.25
3.14.1 Equalisation with High Q Systems 3.26
3.14.2 Equalisation with systems having High Resonant Frequencies 3.26
3.14.3 Equalisation with Non-linear Systems 3.26

Chapter 4 Installation

4.1 External Connections 4.1
4.1.1 Mains (ac Supply) Input 4.1
4.1.2 Generator and Monitor 4.2
4.1.3 Signal Inputs 4.2
4.1.4 Video Outputs 4.3
4.1.5 Interlock 4.4
4.1.6 GPIB 4.4
4.1.7 Analogue Plotter 4.4
4.2 Accessories 4.5
4.3 Ventilation 4.5
4.4 Rack Mounting 4.6
4.4.1 Mechanical Stability 4.6
4.4.2 Ventilation 4.6
4.4.3 Telescopic Slide Fitting Procedure (Option 12001A) 4.7

Chapter 5 External Control via the GPIB

5.1 Introduction 5.1
5.2 Command Overview 5.1
5.2.1 GPIB Commands 5.2
5.2.2 GPIB Command Format 5.2
5.2.3 Output Data Format 5.3
5.3 Setting the Keyboard 5.3
5.4 Reading the Keyboard 5.4
5.5 Controlling the Tests 5.5
5.6 Accessing the Data Buffers 5.6
5.6.1 Buffer Command Format 5.7

5.6.2 Binary Data Transfers 5.7
5.6.3 Binary Data Formats 5.7
5.6.3.1 Exponent Format 5.7
5.6.3.2 Data Format 5.8
5.6.4 ASCII Data Transfers 5.8

5.7 Interface Facilities 5.8

5.7.1 GPIB Local-remote 5.8
5.7.2 Interface Addresses 5.9
5.7.3 Parallel Poll Configure 5.9
5.7.4 End or Identify (EOI) 5.9
5.7.5 Controller Capability 5.9
5.7.6 Talk Only 5.10
5.7.7 GPIB Connector 5.10

5.8 GPIB Commands 5.10
5.9 Index of GPIB Commands 5.19
5.10 Application Examples 5.20

5.10.1 Save, Clear, and Load Test Store 5.20
5.10.2 Reading Data from the RVC in ASCII Format 5.21
5.10.3 Writing Data to the RVC in ASCII Format 5.22
5.10.4 Reading Data from the RVC in Binary Format 5.23
5.10.5 Writing Data to the RVC in Binary Format 5.24
5.10.6 Conversion of RVC Binary Data 5.24
5.10.7 GPIB Plotter 5.25

5.11 Command Syntax 5.27

5.11.1 Syntax Definition 5.27
5.11.2 Numeric Format Definition 5.27
5.11.3 Nomenclature for Syntax Definition 5.28

Chapter 1
RVC Capability

CONTENTS *Page*

1.1	Introduction	1.1
1.2	Power-up State	1.1
1.3	Control Keyswitch	1.2
1.4	Manual Control	1.2
1.5	Display	1.2
1.6	Battery Sustained Store	1.2
1.7	Design Standard	1.2
1.8	Specification	1.3

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07241

CHAPTER 1 RVC CAPABILITY

1.1 INTRODUCTION

The Random Vibration Controller (RVC) is an adaptive loop controller for use in a random vibration test system.

By allowing engineering systems, including structures, to be pseudo-randomly excited over the frequency band 6Hz to 3kHz, in accordance with a user defined vibration spectrum, the RVC is able to simulate a typical working environment and to provide an adequate test for these systems.

The adaptive loop is shown in Fig 1.1. A filtered random signal is generated by the RVC and is used to excite the system under test (SUT), via an electromechanical shaker and a power amplifier. The resultant vibration is monitored via an accelerometer, and Fast Fourier Transform (FFT) techniques are used to estimate the power spectral density (psd) of the vibration signal. An adaptive control algorithm adjusts the filtered random signal to obtain a psd which approximates to a user defined vibration spectrum – the 'demand profile'.

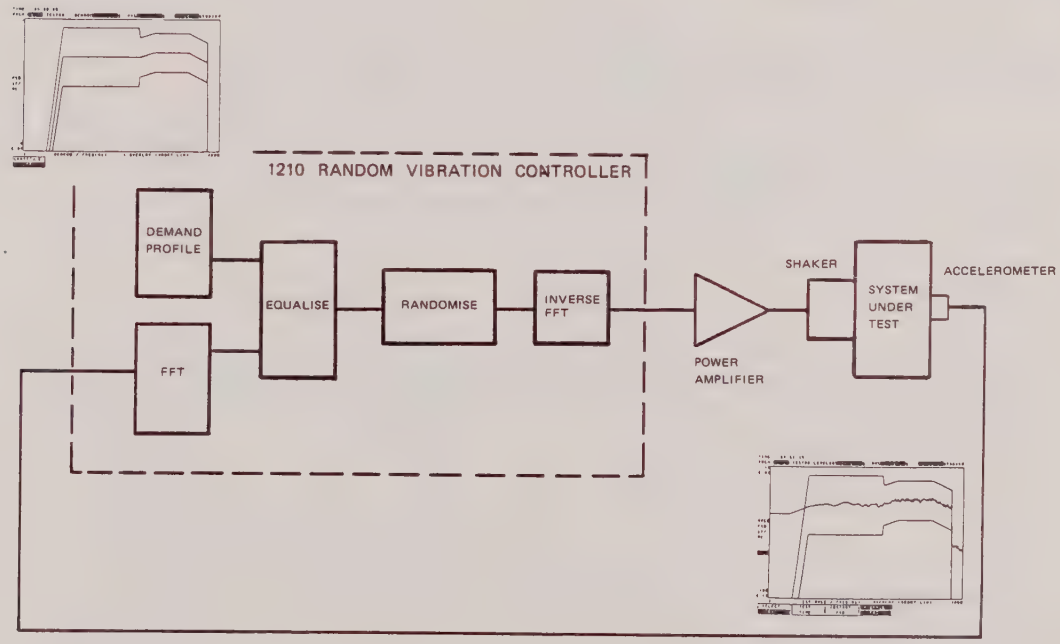


Fig. 1.1 *The adaptive loop*

1.2 POWER-UP STATE

Main power to the RVC is controlled with a red POWER button, situated on the left of the instrument between the display and the horizontal keyboard. On power-up, an automatic test is made to ensure that the digital circuitry of the RVC is functioning correctly. On completion of the test the instrument enters its initial working state and is ready for use. The general approach to operating the RVC is described in Chapter 2, whilst detailed instructions for operating individual controls are given in Chapter 3.

1.3 CONTROL KEYSWITCH

A key operated, three position switch is provided on the front panel to allow the instrument to be set into its basic operating state, 'Program', 'Local', or 'Remote'.

'Program' allows access to all front panel functions to define test parameters and to provide full front panel control of the test.

'Local' inhibits the PROGRAM, OPEN LOOP and self test keys. All display and cursor keys are operational. The CLOSED LOOP key group may be used to run vibration tests.

'Remote' inhibits the PROGRAM, OPEN LOOP, CLOSED LOOP (except for ABORT) and self test key groups. All display and cursor keys are operational. The RVC may be commanded to run vibration tests with a 'Drive Request' interlock signal, obtained by the closing of external potential-free contacts.

In the EXT control mode, i.e. GPIB control, the position of the keyswitch is ignored and the desired mode may be selected remotely.

1.4 MANUAL CONTROL

The functions are implemented using the main keyboard, which contains a series of defined, or 'hard', keys and a complementary series of menu, or 'soft', keys.

The hard keys are grouped in a logical sequence on the horizontal keyboard, whilst the soft keys are arranged below the display. The soft keys are used to select from a menu of functions, presented at the bottom of the display, appropriate to the main key selection.

1.5 DISPLAY

A clear display of the estimated spectral data and the demand profile, together with alphanumeric information defining spectral values, the machine status and other control data is provided by a raster scan CRT. Values for the data displayed can be established by the use of the cursors.

1.6 BATTERY SUSTAINED STORE

Controller settings are retained in a battery backed, non-volatile store for at least 600 hours after the mains power has been switched off.

1.7 DESIGN STANDARD

At a modest cost, the RVC satisfies the requirements for a high quality dedicated random vibration controller and the design incorporates many features usually regarded as optional extras. Advanced graphics and the hard key/soft key combination make the instrument suitable for a wide range of operator skills. The RVC will therefore satisfy the demands of the larger test houses, as well as those of production/qualification testing. The standard specification of the instrument fully covers the requirements of military standards such as MIL STD 781C(D), 810C(D) NAVMAT P9492, and similar test programs.

SPECIFICATION

Frequency range: 6Hz to 3kHz
Resolution: 6Hz (500 lines)
12Hz (250 lines)
24Hz (125 lines)
Dynamic range, drive psd: > 65dB
demand psd: 40dB max
demand grms: > 60dB

Input characteristics

Coupling: ac
Charge input, single ended, microdot connector
source impedance: > 50MΩ, < 10000pf
range, 6dB increments:
10pC to 10nC peak
Voltage input, differential or single ended, BNC connector
input impedance: 1MΩ, < 75pF
range, 6dB increments:
10mV to 10V peak
common mode: 30V peak max
common mode rejection, 50(60)Hz:
> 65dB
Accelerometer sensitivity range 10^{-18} to 10^{18} pC/g or mV/g

Output characteristics

Output signal, pseudo-random binary sequence (PRBS)
with Gaussian amplitude probability density function
Random sequence period: > 20 years
Crest factor, range in 0.1 increments: 1.4 to 8
Drive level: 20V peak-to-peak max
Residual noise (6Hz to 30kHz): < 100μV rms
Differential output, shaker drive,
impedance: 400Ω
common mode voltage: 2V peak
common mode rejection,
50(60)Hz: > 50dB
Single ended output, oscilloscope monitor,
impedance: < 1kΩ

Control characteristics

Loop period: 167ms
Equalisation time, critically damped equalisation of up to 60dB step change, over 500 lines, to ± 1.5dB (90% confidence): < 6s
Control error, 6Hz to 3kHz
charge input 1000pF source: < 0.5dB
3500pF source: < 0.7dB
voltage input < 0.5dB

Options

30 inch cabinet slide mounting kit 12001A
Jonothan slide mounting kit 12001E
GPIB Interface 12002A
IEEE Standard 488 (1978) with full remote control
Switch selected "talk only" for output to HP Graphics
Language compatible digital plotter
Maximum transfer rate: 256kbyte/s
Interface functions: SH1, AH1, T5, TE0, L4
LE0, SR1, RL1, PP2, DC1
C0, DT1, E1
Analogue Plotter Interface 12003A
Pen down – contact closure, or opening
X- and Y-axis voltage: 0 to 10V nominal

General

Power supply 115V ± 10%, 60Hz
230V ± 10%, 50Hz
consumption: 320VA max
Environment,
temperature, operating: 0°C to 45°C
storage: −30°C to 70°C
humidity (non condensing): 76%

Vibration: Tested in accordance with IEC 68 (BS2011)
Safety: Designed to comply with IEC 348 (BS4743)
Dimensions,
height: 284mm (11.2in)
width: 432mm (17.0in)
depth: 698mm (27.5in)
Weight: 30kg (67 lbs)

Chapter 2
Operating Procedure

CONTENTS *Page*

2.1	Closed Loop Control	2.1
2.1.1	Status	2.1
2.1.2	Test Number	2.1
2.1.3	Input Configuration	2.3
2.1.4	Drive Calibration	2.4
2.1.5	Analysis Configuration	2.4
2.1.6	Display	2.5
2.1.7	Demand Spectrum Profile	2.6
2.1.8	Demand grms Levels	2.8
2.1.9	Protect Limits	2.9
2.1.10	Drive Limits	2.10
2.1.11	Closed Loop Operation	2.11
2.2	Analysis Mode	2.14

CHAPTER 2 · OPERATING PROCEDURE

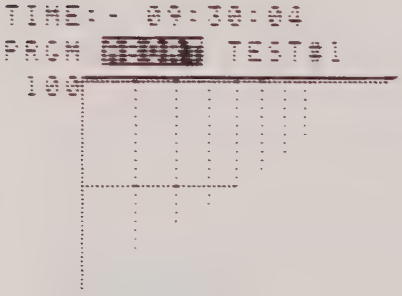
In this Chapter two setting up procedures are described to familiarise the user with typical test routines. In Chapter 3 a full description of each control function is given, with a discussion of the test parameters available.

2.1 CLOSED LOOP CONTROL

This section outlines the procedure to be adopted to set up and run a closed loop test, in which the demand spectrum is defined, the test spectrum equalised at a level below the required test level, and the test completed by running at the full demand level, with an equalised spectrum.

2.1.1 Status

To enable a sequence to be programmed the keyswitch must be in the PROGRAM position, confirmed by the status message PRGM at the left of the second status line in the display.

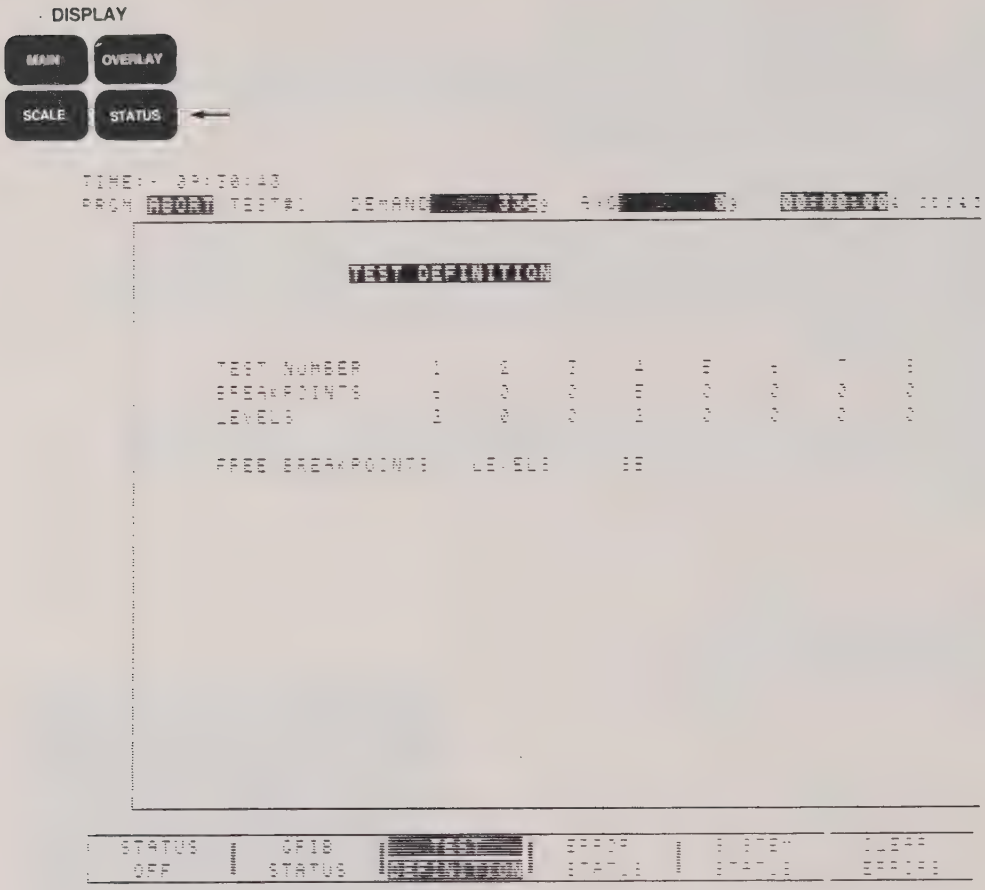


Also, the RVC should be in ABORT, this being confirmed by the status message in reverse video in the second status line.

If the RVC is in another state press the ABORT key; this will shut down the drive system.

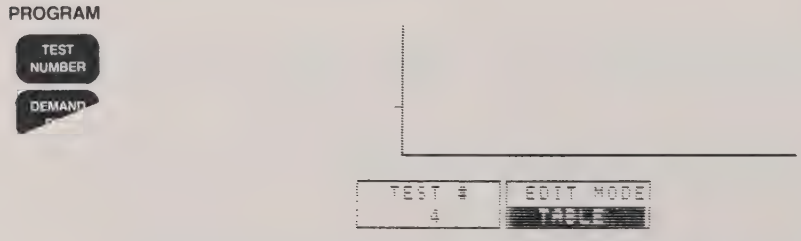
2.1.2 Test Number (3.6.1)

The first parameter to be defined is the identifying number for the test. Any number between 1 and 8 inclusive may be entered via the numeric keypad and Test # key in the TEST NUMBER menu, but before this is done it may be necessary to ascertain which numbers are available. To do this look at the TEST DEFINITION status page, which is accessed via the STATUS hard key.



A test number is available if no breakpoints or levels have been defined for it. In this case, a zero is displayed against 'BREAKPOINTS' and 'LEVELS' under the test number.

If an undefined test is available the relevant TEST # number should be entered via the TEST NUMBER menu:



The status display will show the test # number selected:

Whilst in the TEST NUMBER menu the type of display required while defining the demand profile should also be selected, using the EDIT MODE key. For the purpose of this description a graphic display is used, rather than tabulated information, therefore MENU has been selected.

If all test numbers have been allocated, a test may be cleared via the SELF TEST menu:

To clear Test 4, for example, press the CLR TEST # soft key, then ENTER '4' from the numeric keypad. The number of the test cleared is entered automatically and displayed.

2.1.3 Input Configuration (3.5.1)

To set up the input stage, select the SET INPUT menu:

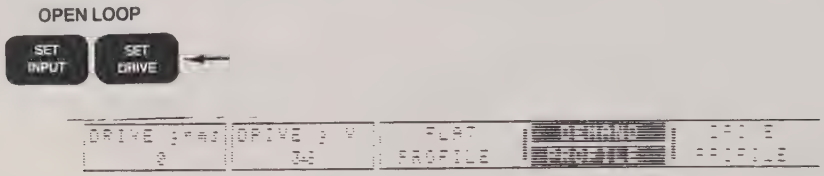
The appropriate ACCL TYPE should be chosen to suit the transducer configuration; mV/g for a voltage input from a charge amplifier, for example, or pC/g for a direct accelerometer input. The accelerometer sensitivity, in units appropriate to the ACCL TYPE, is normally set automatically using the calibration procedure described in Chapter 3, Section 3.4.6. A known value can, however, be entered from the numeric keypad.

The input range is now specified and, for a closed loop test, AUTO is preferable. The fourth soft key (RANGE) is ignored, since this is now a status indication only.

For single ended, voltage, inputs the LO INPUT should be GROUNDED; otherwise, ACTIVE should be selected. Input connection details are given in Chapter 4, Section 4.1.3.

2.1.4 Drive Calibration (3.5.2)

The generator output is specified using the SET DRIVE menu:



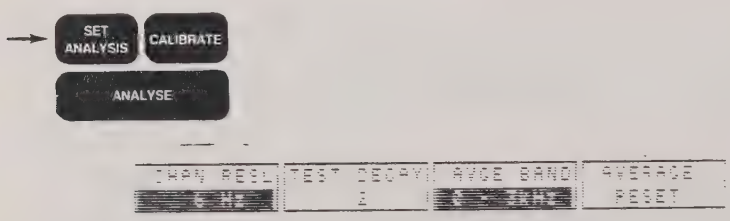
The three right hand keys in this menu may be ignored for closed loop control; they are used only for setting up the drive in ANALYSE.

To enable the controller to generate an output voltage consistent with the required drive acceleration it is necessary to set an appropriate drive sensitivity (g/V). If the sensitivity is too low the test signal input to the controller will be insufficient for equalisation to occur: if the sensitivity is too high the initial low level drive may damage the system under test. The drive sensitivity value is normally set automatically, using the calibration procedure discussed in Section 3.4.6 and is calculated from the CALIBRATED DRIVE g PEAK and CALIBRATE LEVEL V PEAK. If known, the value may be entered directly, using the numeric keypad.

The DRIVE grms key is used only for status information in CLOSED LOOP and displays the present drive signal acceleration level, calculated according to the sensitivity specified above.

2.1.5 Analysis Configuration (3.5.3)

The analysis configuration is now set up using the SET ANALYSIS menu:



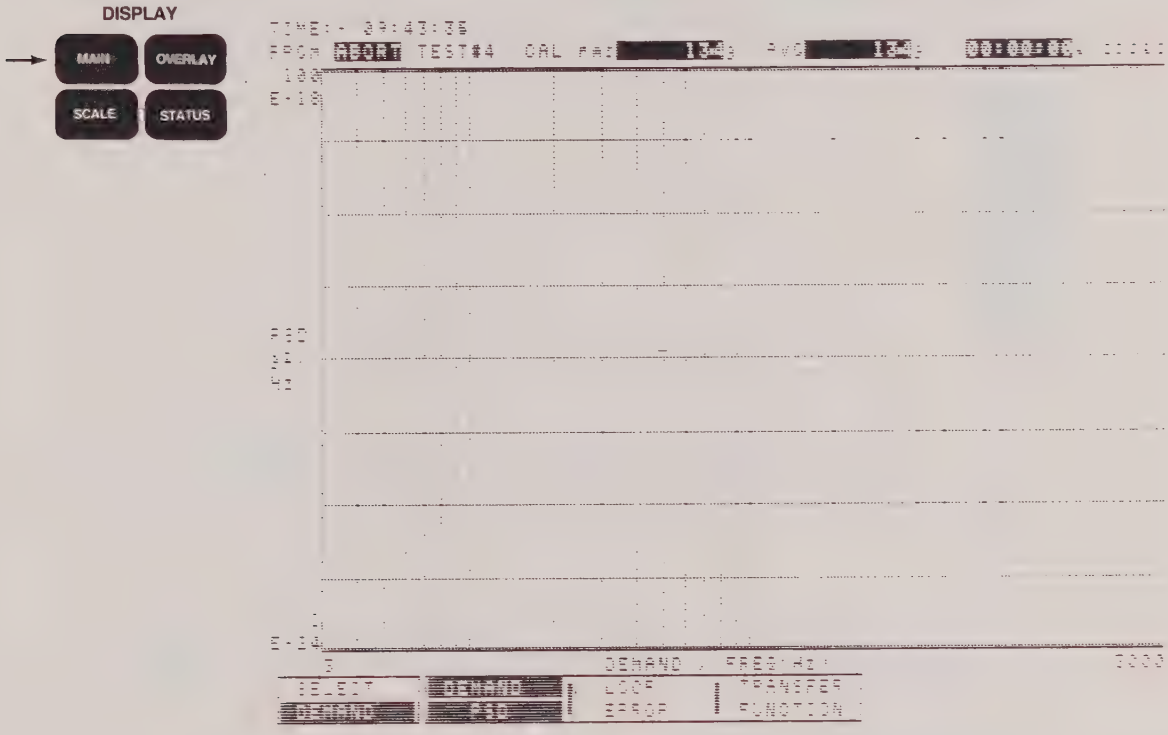
First, a suitable frequency resolution should be selected. Generally the highest resolution consistent with control stability is used. If the system response is non-linear, or contains high 'Q' resonances, it may be necessary to reduce the resolution to improve the apparent equalisation (see Chapter 3, Section 3.5.3). The resolution is specified by selecting 6Hz, 12Hz, or 24Hz, with the CHAN RESL key.

Control of the test variance and the system response time is specified with the TEST DECAY soft key. A value of 2 seconds is suitable as a first approximation.

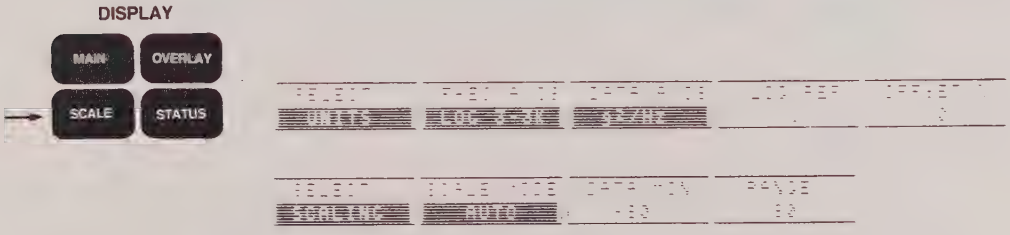
Averaging may be accomplished over the entire 3kHz band or, alternatively, parts of this band may be masked by the demand psd profile, thus allowing the test average grms to be calculated over a selectable frequency range.

2.1.6 Display (3.7)

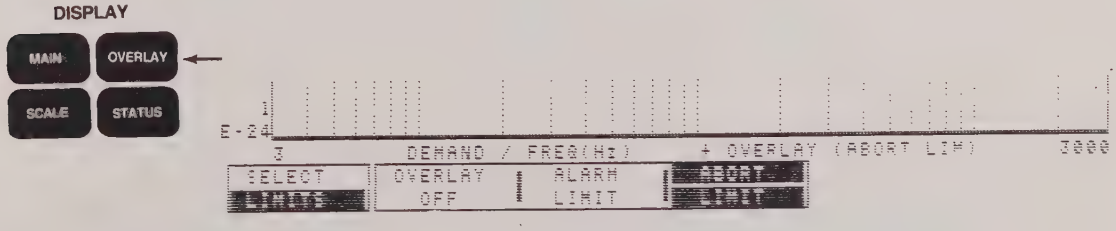
In preparation for defining the demand psd profile, the DEMAND PSD display is now selected via the MAIN DISPLAY menu:



The SCALE selection is also made at this point. In the present example, the scale default values are used; these are:



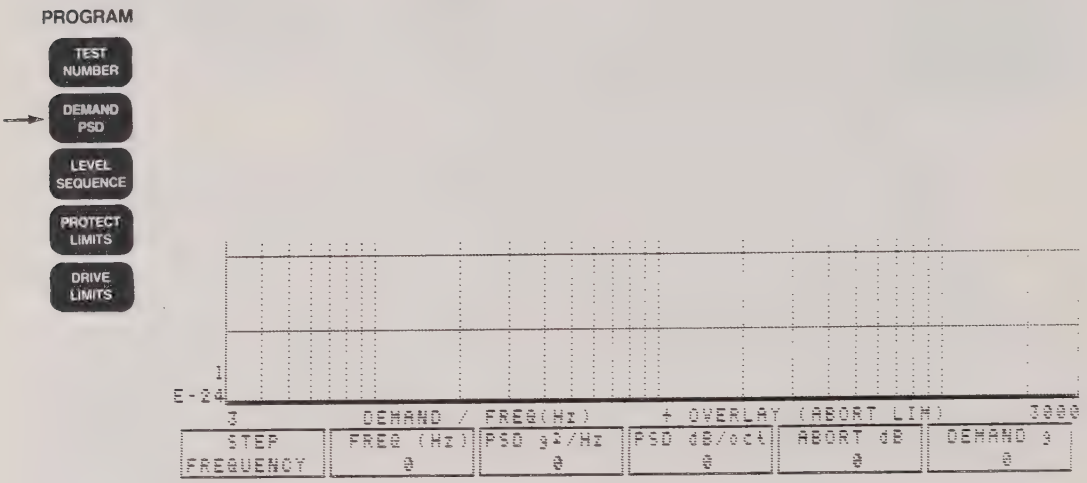
If it is intended to use abort limits then these may be overlayed with the demand profile. Select OVERLAY, LIMITS, ABORT LIMIT:



The procedure outlined in the preceding sections completes the basic configuration for both open loop (analyse) and closed loop operation. The following procedure enables the specific closed loop test parameters to be defined using the PROGRAM keys (3.6).

2.1.7 Demand Spectrum Profile (3.6.2)

To define the required test response profile (known as the demand profile) the DEMAND PSD menu is used. This allows the frequency and amplitude, or slope, to be specified for each segment of the profile. Select DEMAND PSD:

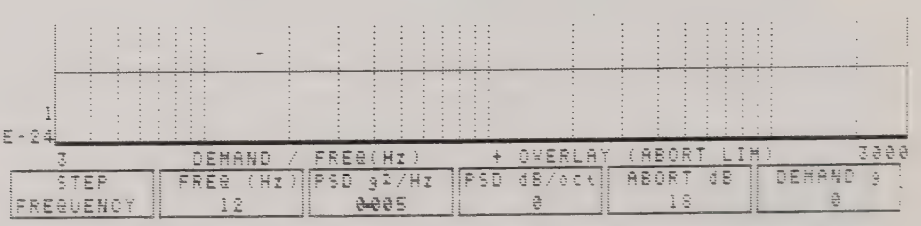


For a vacant test the DEMAND menu values will be zero; except for ABORT dB, which defaults to 20dB (åppears when the first FREQ (Hz) value is entered).

The first FREQ(Hz) value must be greater than zero. If the value is not an integer multiple of 6Hz then it will automatically be converted to the nearest integer multiple.

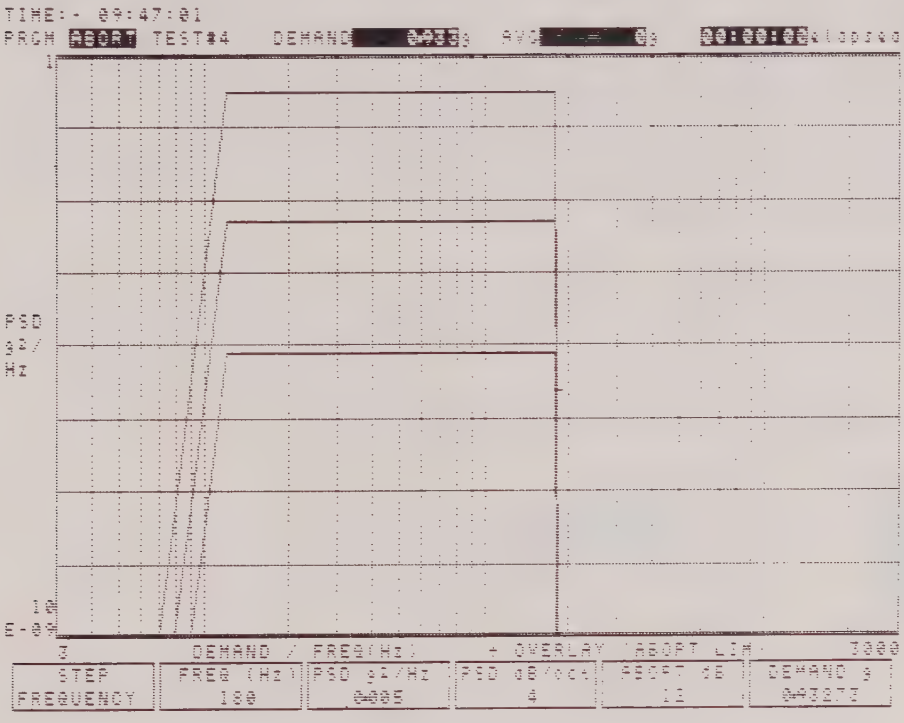
Next, enter the required psd (PSD g^2/Hz). If the next frequency breakpoint is to be defined by frequency and the rate of change of psd from the present breakpoint the slope should be entered also, under PSD dB/oct. For the first breakpoint, the frequency and amplitude must both be defined.

The first segment entry is completed by defining the ABORT dB limits, if abort limits other than ±20dB are required:

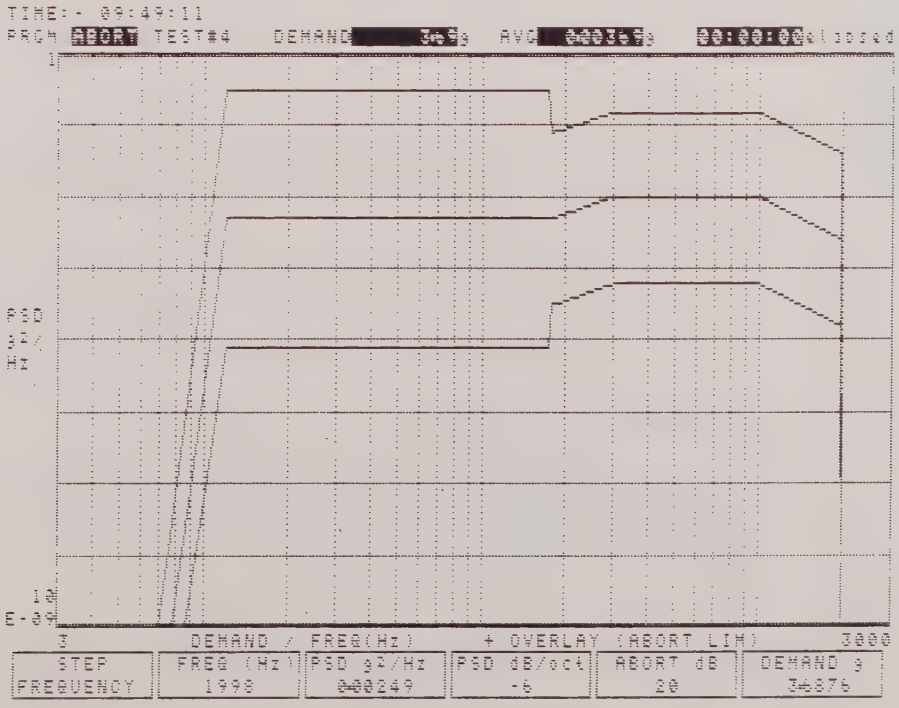


The next breakpoint is defined by pressing FREQ(Hz) and entering the required frequency value. The PSD g^2/Hz value displayed will be either the same as that of the previous breakpoint, or, if a slope was defined, a psd based on that slope. If required, a different psd value may be a entered from the numeric key pad. The value displayed for the slope is that defined for the previous breakpoint and, again, a different value may be assigned.

Once the second breakpoint has been defined, the first segment is displayed and the DEMAND g value is updated:



The above procedure should be repeated for each breakpoint, until the complete profile has been defined:



If the absolute psd values are to be used in the actual test, a note should be made of the DEMAND g value obtained for the complete profile.

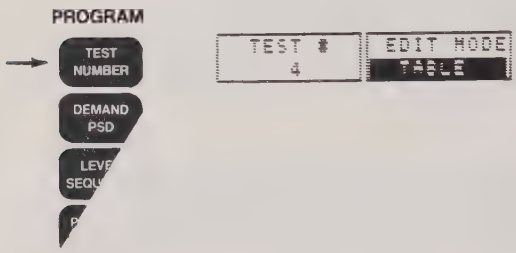
The values entered for each frequency breakpoint may be checked with the aid of the STEP FREQUENCY soft key. If this key is used in conjunction with the shift key the entries will scroll back from a higher frequency to a lower frequency. A breakpoint may also be accessed directly by entering its particular frequency via the FREQ(Hz) key.

Values entered in error for a specific segment may be cleared by entering a zero value for FREQ(Hz), at the frequency of the breakpoint to be deleted. A complete profile may be cleared by using the 'self test' INIT STORE menu.

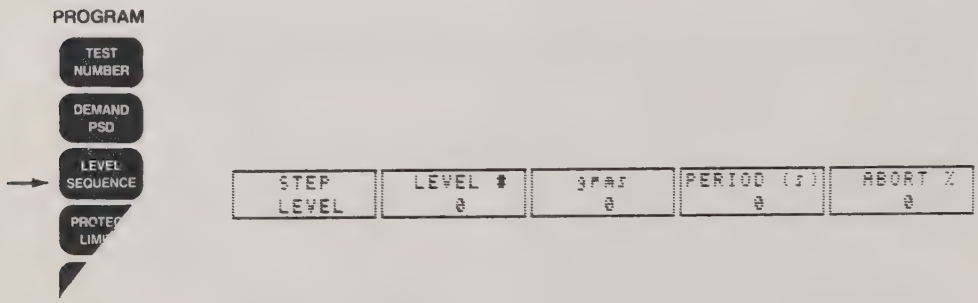
2.1.8 Demand grms Levels (3.6.3)

The DEMAND PSD menu defines the shape of the profile but not the absolute amplitude used in the test. This amplitude is now defined, using the LEVEL SEQUENCE menu.

If several levels are to be defined for a particular test, it is advantageous to use the tabular display format. This is selected via the TEST NUMBER menu:



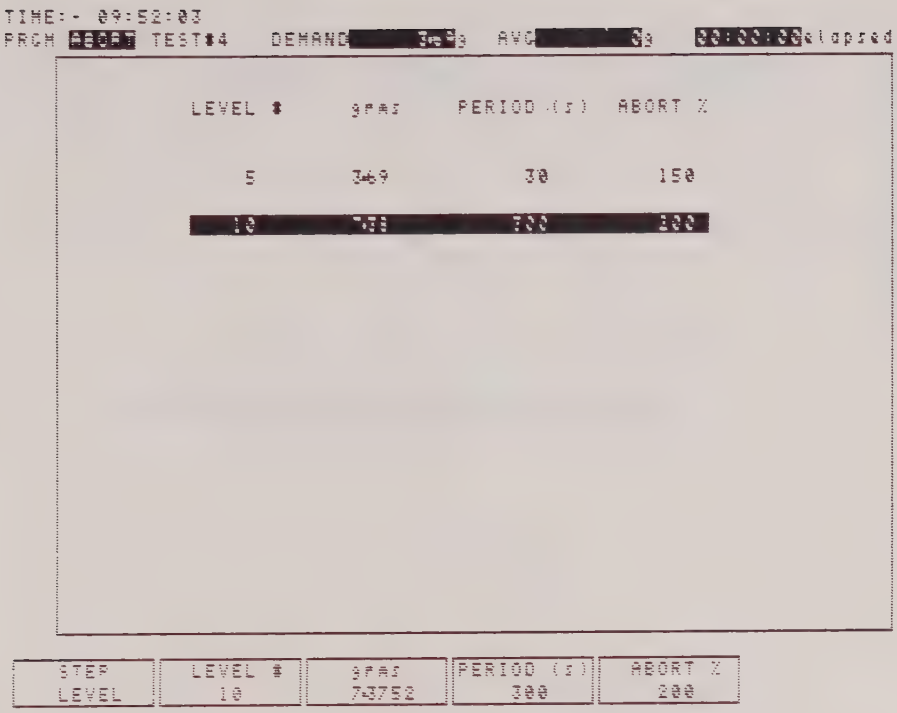
The LEVEL SEQUENCE menu is then selected:



A series of up to ten drive levels may be defined and for each one the following information is entered:

LEVEL #	A reference number between 1 and 99.
grms	The total demand acceleration level.
PERIOD	The time, in seconds, for which the level is to be applied to the system under test. (Zero defines a continuous test.)
ABORT %	Test grms limit as a percentage of the demand grms.

In the present example two levels are defined, as shown at the top of page 2.9.



If it is required to subject the system under test to the absolute psd amplitudes defined in the DEMAND PSD menu, make the grms value equal to the DEMAND g value.

A PERIOD value of zero will cause the signal to be applied for an infinite time, subject to the ABORT LIMITS and to the use of the ABORT key.

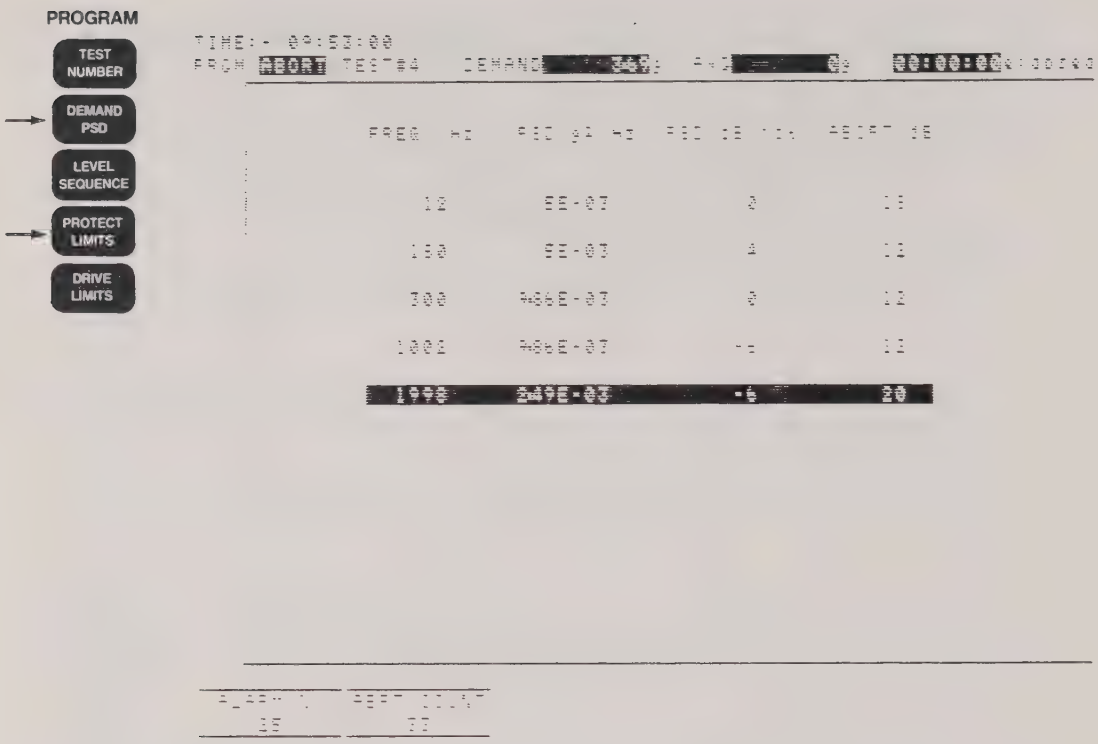
For overall system protection, the level sequence ABORT % key allows a limit to be entered for the average test acceleration level, expressed as a percentage of the demand grms. The default value is 200%, but a value between 100% and 1000% may be entered from the numeric pad.

2.1.9 Protect Limits (3.6.4)

The protect limits are defined by the ALARM % and ABRT COUNT (abort count) values, which are entered via the PROTECT LIMITS menu.

The ALARM % value defines the test level at which an alarm message will be given. This value is defined as an integer percentage, between 1% and 100%, of the ABORT dB level (as defined in the DEMAND PSD menu). If, for example, an ALARM% value of 20 is entered and the given segment has a 20dB abort limit specified then the alarm level will be ± 4dB from the demand spectrum.

Since the ALARM % value is related to the ABORT dB value(s) of a demand profile, it may be useful to view these, in tabular form, when defining the ALARM % value. Simply press the DEMAND PSD hard key and then the PROTECT LIMITS hard key. This assumes that TABLE is selected under EDIT MODE in the TEST NUMBER menu. In the present example, TABLE was selected prior to defining the demand grms levels (2.1.8).



ABRT COUNT defines the number of channels allowed to exceed the ABORT dB level before a test is aborted. Any integer between 1 and 501 may be entered. The value 501 switches off the ABORT limits. The abort count value also defines the control confidence levels, as explained in Section 3.6.4.

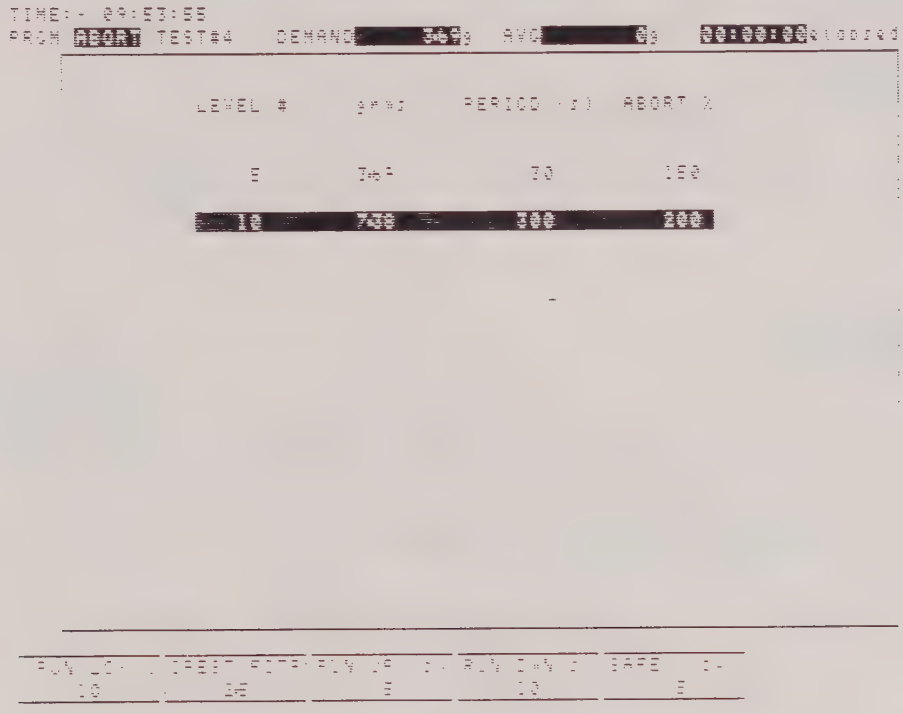
2.1.10 Drive Limits (3.6.5.)

The DRIVE LIMITS menu is used to define the following drive parameters:

RUN LOW %	The acceleration level for system equalisation. This should be specified as a percentage of the demand grms, between 0.1% (−60dB) and 100% (0dB). The default value is 10% (−20dB).
CREST FCTR	The crest factor (peak to rms voltage, or acceleration, ratio) of the drive signal. Any value between 1.4 and 8 may be entered. The default value is 2.
RUN UP (s)*	The time, in seconds, over which an increase in signal level shall occur. The default value is 3 seconds.
RUN DWN (s)*	The time, in seconds, over which a decrease in signal level shall occur. The default value is 3 seconds.
SAFE V(pk)	The peak voltage to which the drive signal is to be limited. Any value between 0(V) and 10(V) may be entered. The default value is 1(V).

* The times set for RUN UP and RUN DOWN apply for all changes in drive level, except for ABORT. In the latter case the drive signal is shut down smoothly within 0.5 seconds.

Since the drive limits are related to the drive levels selected in the LEVEL SEQUENCE menu it may be useful to view these, in tabular form, whilst defining the drive limits. Simply press the LEVEL SEQUENCE hard key and then the DRIVE LIMITS hard key. This assumes that TABLE is selected under EDIT MODE in the TEST NUMBER menu. In the present example, TABLE was selected prior to defining the demand grms levels (2.1.8).

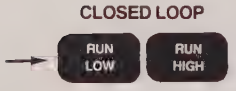


The setting up procedure for a closed loop test is now complete and the test may be run.

2.1.11 Closed Loop Operation (3.4.2, 3.4.3)

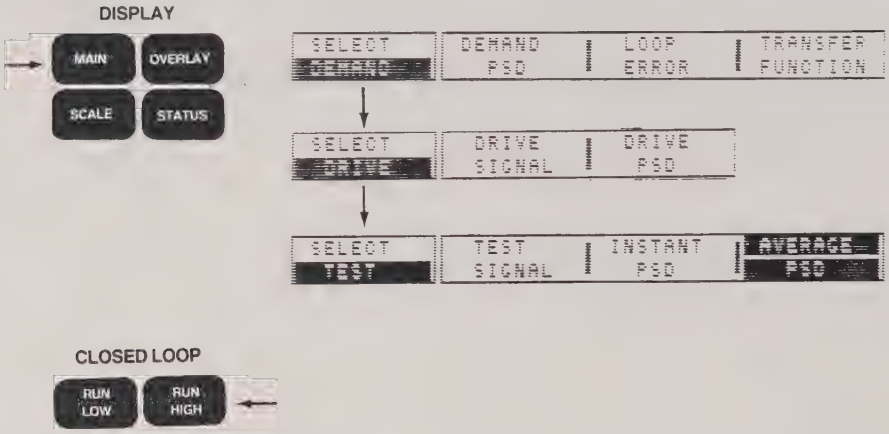
The RVC carries out a test run in two stages; first, in RUN LOW, it allows the spectrum of the test signal to 'equalise' to the demand profile at a preselected percentage of the full drive level, then, when equalisation is complete, selection of RUN HIGH allows the test signal to ramp up to its full level to begin the test.

Normally, the operator will start the test by pressing the RUN LOW key.

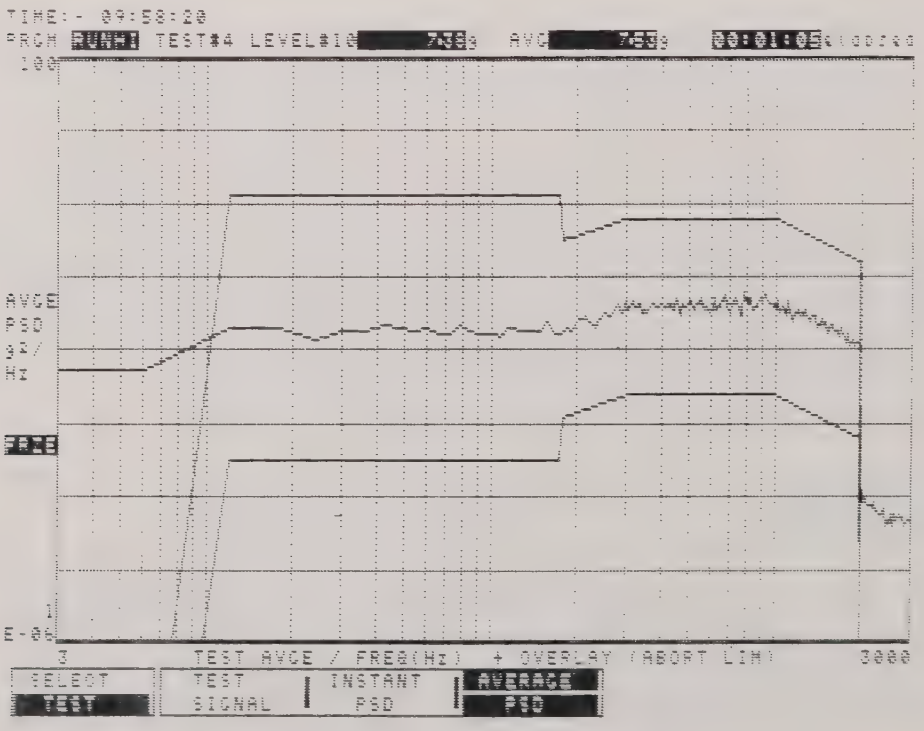


The drive signal will then ramp up to the RUN LOW level entered in the DRIVE LIMITS menu and the system response (test spectrum) will be forced to follow the demand profile specified in the DEMAND PSD menu by automatic adjustment of the output (drive) signal. RUNLO will be indicated in the status lines at the top of the display:

At this point another display can be selected, to show, for example, the TEST, INSTANT PSD, TEST, AVERAGE PSD, or DRIVE PSD. A flashing error message 'ALARM, PSD OUTSIDE LIMIT' indicates that equalisation is incomplete.



Selection of RUN HIGH will cause the drive signal to ramp up to the level required by the actual test once the system has equalised. The status display will then show RUNHI and the elapsed time indicator in the top right hand corner of the screen will show the time from entering the RUN HIGH state.

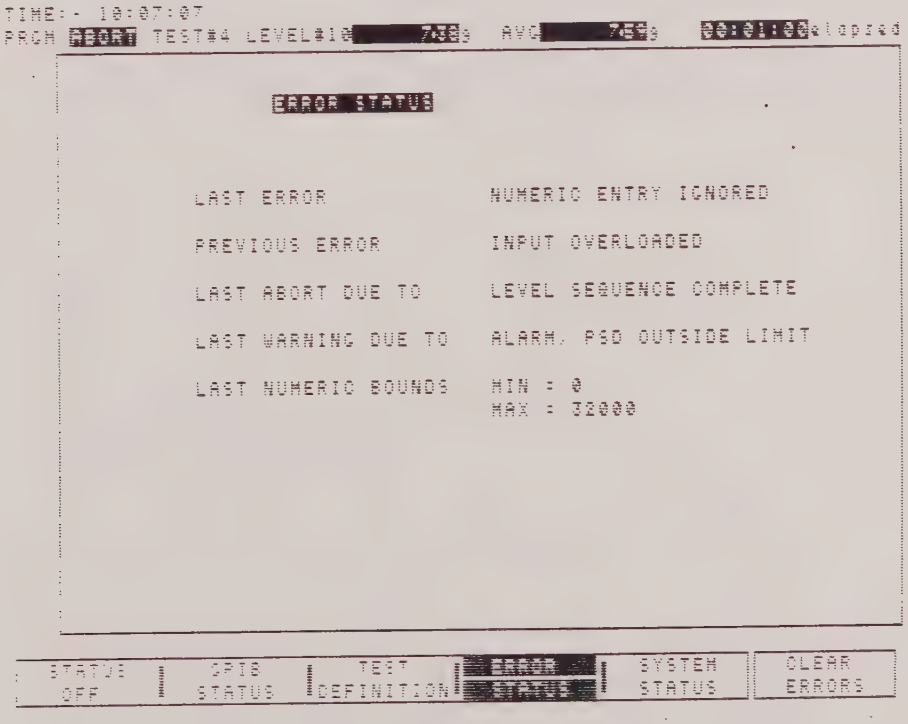


The display above shows the average psd, in g^2/Hz, of the system under test, after an elapsed time of 1 minute and 5 seconds. At this point the drive is working on Level #10. The elapsed time and level can be ascertained from the second status line at the top of the display.

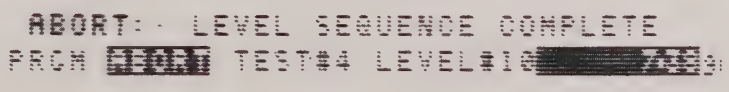
If RUN HIGH is selected without pressing the RUN LOW key, the RVC will equalise the system at the low level first, before ramping up to the actual test drive level automatically.

With high Q systems a test may be aborted immediately RUN LOW or RUN HIGH is selected, when the message 'ABORT: OPEN LOOP' or 'ABORT: grms LIMIT EXCEEDED' will be displayed. In many cases this indicates a need to recalibrate the drive sensitivity, as described in Section 3.14.

During the test run various operator messages may be momentarily displayed. A message may be a warning, an error message, or an abort message. The last error message displayed, and the error message previous to that, may be reviewed on the ERROR status page, with the last warning and the last abort message. The meaning of some operator messages is self evident, but a complete explanation of all operator messages is given in Chapter 3, Section 3.13.



When a test, for which a finite time has been programmed, is completed, the message 'LEVEL SEQUENCE COMPLETE' is displayed and ABORT is entered:



2.2 ANALYSIS (3.4.1)

To perform an analysis the RVC acts, in an open loop, as a filtered noise source with spectrum analysis facilities. Many of the test parameters described for closed loop control are used to define the generator and input system characteristics. Therefore, all the initial test set-up functions, grouped under the OPEN LOOP heading, apply. The DRIVE LIMITS parameters are also used.

The drive signal level is no longer adjusted automatically, but specified using the SET DRIVE, DRIVE grms key. The drive signal spectrum also is selected manually, from the SET DRIVE menu, and can be flat (FLAT SPEC), shaped to the demand profile (DEMAND PSD), or shaped to the last equalised drive spectrum (DRIVE PSD). The drive psd spectrum will have been established by defining the demand profile (DEMAND PSD hard key) and equalising the test spectrum to this in RUN LOW.

It should be noted that neither alarm nor abort checks will be implemented in ANALYSE, although, if the drive signal is forced to exceed 10V pk, the RVC will default to ABORT.

An analysis is started by pressing the ANALYSE key, which causes the specified drive signal to be output to the SUT. The status display will then show ANLYS to indicate that the RVC is now operating in OPEN LOOP. When ANALYSE is entered from ABORT the DRIVE grms is initialised to zero and hence it is necessary to enter the required DRIVE grms value after pressing the ANALYSE key.

When ANALYSE is entered from a closed loop state the DRIVE grms setting and drive source selection are automatically set to maintain the closed loop drive conditions. Note, however, that the alarm and abort checks are disabled on entry to ANALYSE.

Chapter 3
Front Panel Key Functions

CONTENTS

		Page
3.1	Power Switch	3.1
3.2	Brilliance and Contrast	3.1
3.3	Main Keyboard and Soft Keys	3.1
3.4	Closed Loop, Open Loop, and Calibrate	3.3
3.5	Analysis Keys	3.7
3.6	Program Keys	3.8
3.7	Display and Cursor Controls	3.12
3.8	Numeric Entry	3.19
3.9	Self Test	3.20
3.10	'rtl' Key	3.20
3.11	Control Keyswitch	3.20
3.12	Interlock	3.21
3.13	Operator Messages	3.23
3.14	Recovery From Failure to Equalise	3.25

CHAPTER 3 FRONT PANEL KEY FUNCTIONS

3.1 POWER SWITCH

Main power to the RVC is controlled with the red power button, situated on the left of the instrument between the display and the horizontal keyboard (see Fig 3.1). The button has a push for ON, push for OFF action and controls the application of the ac supply (mains) to the internal power supplies. The ON and OFF positions are clearly indicated on the panel below the button.

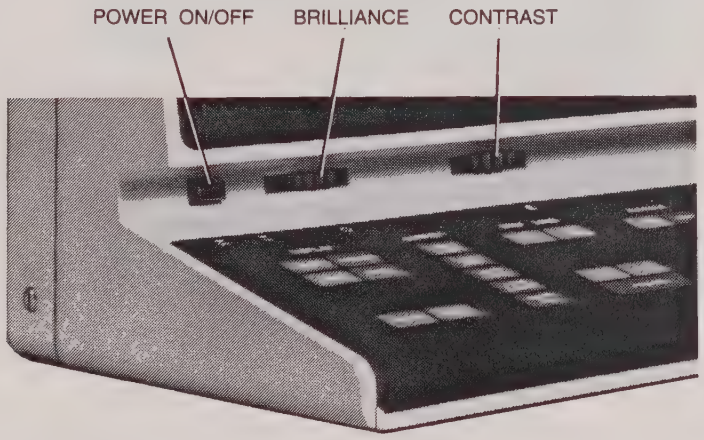


Fig. 3.1 *Power, brilliance, and contrast controls.*

On power up an automatic test is made to ensure that the digital circuitry of the RVC is functioning correctly. On completion of the test the instrument enters its initial working state and is ready for use.

In the event of a power-up test failure, diagnostic information is displayed on the screen.

3.2 BRILLIANCE AND CONTRAST CONTROLS

To the right of the POWER switch are the brilliance and contrast thumbwheel controls. Rotation to the left increases brilliance, or contrast, and rotation to the right decreases it.

3.3 MAIN KEYBOARD AND SOFT KEYS

The RVC functions are implemented using the main keyboard, which contains a series of defined, or 'hard', keys and a complementary series of menu, or 'soft', keys.

The hard keys are grouped in a logical sequence on the horizontal keyboard, whilst the six soft keys are located below the display (see Fig 3.2, overleaf). The soft keys (coloured grey) are used to select from a menu of functions, appropriate to the hard key selection, presented at the bottom of the display. Situated at each end of the row of soft keys is a key outlined in grey, which acts as a 'shift' key.

Chapter 3 contains a full description of the use of each hard key and soft key.

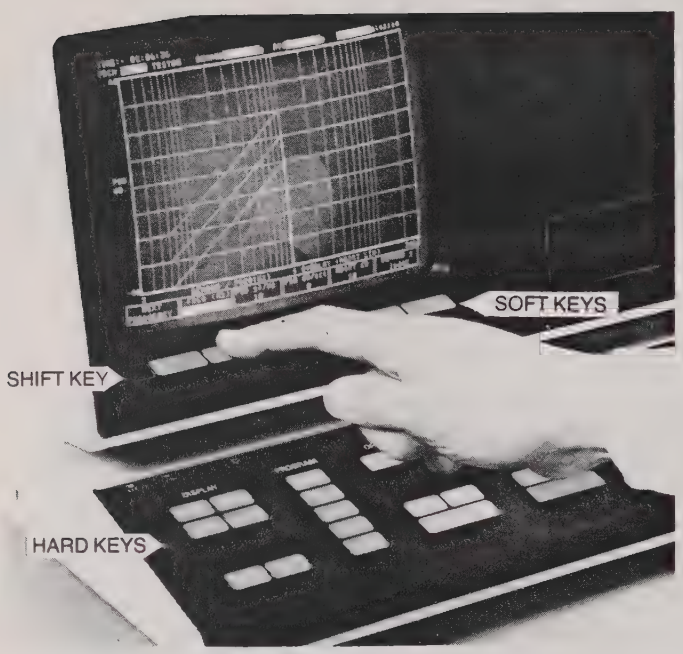


Fig. 3.2 *View of RVC, showing 'hard' keys and 'soft' keys*

The keys may be divided into six groups:

Closed Loop, Open Loop, and Calibrate	(3.4)
Analysis Set-up	(3.5)
Program Set-up	(3.6)
Display Graphics	(3.7)
Numeric Entry	(3.8)
Self Test and rtl	(3.9, 3.10)

The soft keys, called up in the menus associated with these hard keys, may be of three types – multiple option, single option and numeric entry.

The multiple option keys enable the user to select a function from a cyclic list, or 'scroll'. The list is stepped through by repeatedly operating the same key. Examples of this type of key are the SET INPUT, RANGE key when the RANGING is FIXED and the SCALE, FREQ key. If the multiple option key is operated in conjunction with one of the 'shift' keys then the scrolling sequence is reversed.

Single option keys can select only one function and when a series of these keys is used in an interactive group the options available are displayed by the annotation of each key. The function selected is shown in reverse video and by pressing one of the other keys the reverse video display is transferred to the new selection. The OVERLAY functions are examples of single option keys:

Some single option keys are used in isolation, e.g. the LEVEL UP key used in CALIBRATION. (See Section 3.4.6.)

Numeric entry keys allow a value to be assigned to a particular parameter, using the numeric keypad. When such a key is accessed the menu will show the current value for this parameter. When the key is depressed, the prompt character '?' appears in reverse video. The new value is then typed in from the numeric keypad, in either fixed point or exponential format. As it is keyed in each character is checked for validity and if accepted is shown above the soft key in reverse video. The '?' character moves to the right to accommodate each value in the display. Once the full value has been keyed in the ENTER key is pressed. Limit checks are then made on the parameter and if it is acceptable it is displayed in normal video format. If unacceptable, the original value is reinstated and an error message 'NUMBER OUT OF BOUNDS' is displayed at the top of the screen, accompanied by an audible warning.

In some cases a soft key does not have a function, but the legend above it is used to display status information. A typical example is the DRIVE grms key when the RVC is operating in CLOSED LOOP.

3.4 CLOSED LOOP, OPEN LOOP, AND CALIBRATE

The major control state keys are grouped under the main headings OPEN LOOP and CLOSED LOOP on the keyboard.

Some of these keys, namely OPEN LOOP, ANALYSE and all the CLOSED LOOP keys, do not have menus associated with them and therefore the present menu remains selected when such a key is pressed. In certain cases, however, particular arguments within the menu may change to bring them in line with the new state selected. The control state selected using one of these keys is displayed in the status section in the top left hand corner of the display.

3.4.1 Analyse

The ANALYSE key selects a simple analysis in an 'open loop' configuration. With this, the system output is not adjusted to equalize the test spectrum to a user defined spectral profile. The controller acts as a filtered random noise source with spectrum analysis and transfer function estimation facilities.

Pressing the ANALYSE key when in RUN LOW or RUN HIGH will disable the adaptive loop, but will retain the present generator output signal level by automatically selecting the DRIVE GRMS and DRIVE PSD from the SET DRIVE menu (3.5.2).

Selecting ANALYSE from ABORT will reset the average to zero and cause a new average psd to be formed. The generator output (DRIVE GRMS) will, however, remain zero until a value is entered in SET DRIVE, DRIVE g rms.

3.4.2 Run Low

In RUN LOW the RVC operates in a closed loop to equalize the system test spectrum to the user-defined 'demand profile'. The drive level is set to a RUN LOW % value of the full test demand level, using the DRIVE LIMITS menu (3.6.5). The full test demand level is defined in the LEVEL SEQUENCE menu (3.6.3).

Since the system is operating with an adaptive loop any preset limits will be detected, as defined by the DEMAND PSD, LEVEL SEQUENCE and PROTECT LIMITS menus (3.6.2, 3.6.3 and 3.6.4). An 'abort' is executed if the system goes 'open loop', or the smoothed drive level (grms) or the maximum channel abort limits are exceeded, relative to the full demand level. Alarms are indicated if the frequency channel psds exceed the low level alarm limits, but are suppressed until the RUN UP period defined in the DRIVE LIMITS menu (3.6.5).

3.4.3 Run High

RUN HIGH provides the full excitation levels, as defined by the level sequence for the actual vibration test and specified by the program set up keys (3.6).

If RUN HIGH is selected after RUN LOW has equalized the spectrum within limits the drive level is ramped up from its low level to the full demand level. If RUN LOW has not been selected, however, an automatic sequence is started. This ramps the drive level from its present value to the RUN LOW level and waits until the spectrum has been equalized within the alarm limits. Once this has occurred the drive signal is gradually increased to the full demand level.

When RUN HIGH is entered the level sequence timing is started, the elapsed time is indicated in the display, and the level sequencing defined in the LEVEL SEQUENCE menu (3.6.3) is executed.

In RUN HIGH, alarm and abort checks are made also. An abort will be executed if the system goes 'open loop', or the smoothed test amplitude (grms) or the maximum channel abort limits are exceeded (relative to the full demand). While the drive is at the low level the checks are identical to those in RUN LOW. At the full (high) demand level the lower abort tolerance limit and the alarm limits as specified by the PROGRAM keys are included.

3.4.4 Hold

HOLD fixes the drive psd at its present value, retaining the control state and alarm%abort checks which are in use at the time of selection. The level sequence and 'elapsed time' are suspended.

3.4.5 Abort

A manual ABORT causes the drive signal to decay to zero and stops further analysis. The following functions, calculated at the time of selection, are retained:

- ★ average test spectrum (psd),
- ★ demand psd,
- ★ loop error,
- ★ transfer function,
- ★ drive psd.

3.4.6 Calibrate

CALIBRATE can be selected only when the controller is in ABORT. Two menus are associated with the CALIBRATE state and these may be called up at any time. A DRIVE menu allows the signal conditions to be set, whilst a LEVEL menu contains the controls required to perform the test. The appropriate menu is selected using the left hand soft key, marked SELECT.

The DRIVE menu is accessed first and a test FREQUENCY entered (see Fig 3.4). The frequency will be within the range 6Hz to 3kHz, and is selectable in increments of 6Hz.

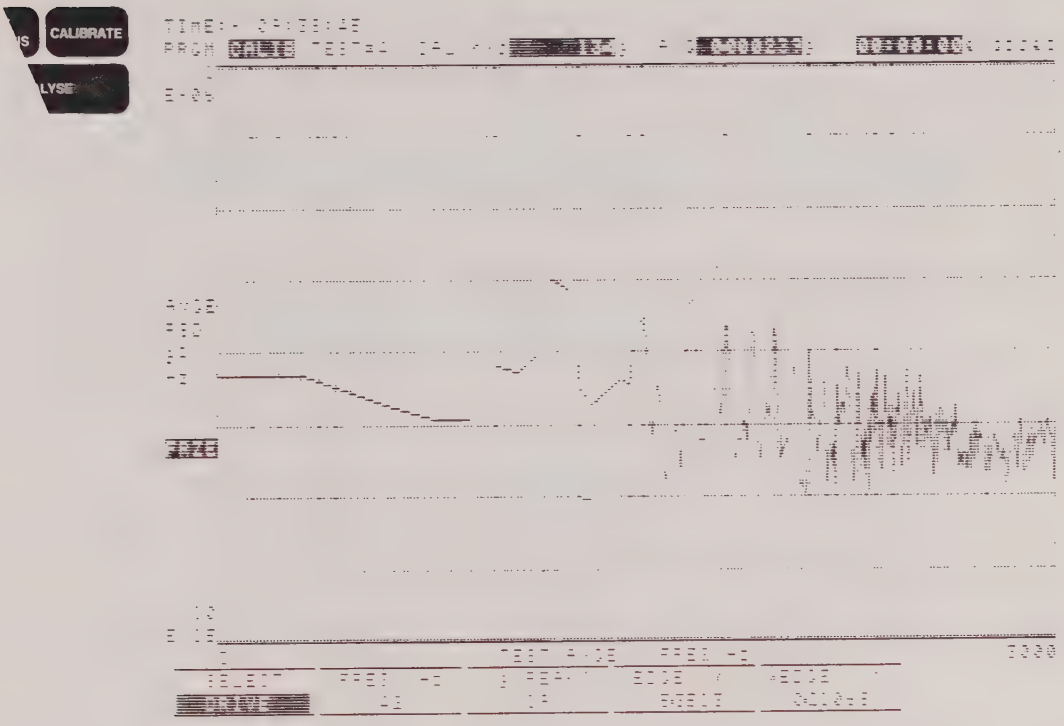


Fig. 3.4 *Selection of calibration DRIVE menu*

The required g PEAK is to be measured at the SUT, or the peak to peak WEDGE (Fopal Triangle) displacement, is then entered. Frequency, acceleration and displacement are inter-related and so only two parameters (one of which must be frequency) need be defined. The third parameter is calculated and displayed by the controller. Thus, it is possible to calibrate by measuring either displacement, or acceleration, externally. The two WEDGE keys simply allow the displacement to be defined in millimetres or inches and when one is defined, the other is automatically updated. If the frequency is changed the last entered parameter of acceleration or displacement retains its value, whilst the other parameter is appropriately updated.

Once the calibration conditions are set up with the DRIVE menu, the LEVEL menu is accessed (see Fig 3.5, overleaf). The output voltage (V PEAK) always defaults to zero on entry to CALIBRATE and the test is started by entering a value for V PEAK from the numeric keypad. Once this value has been entered the calibration drive signal (a sinewave at the selected frequency) is output to the SUT. The drive level may now be incremented or decremented, whilst externally monitoring the resultant g force.

The calibration signal level should be adjusted until the measured g or wedge displacement is equal to that set in the menu. The level is varied by specifying a voltage increment (V INCR) via the numeric keypad and pressing LEVEL UP or LEVEL DOWN as required. The latter keys are auto-repeating and so, if held down, will adjust the calibration voltage continually.

Note that, in CALIBRATE, the drive output is not subject to the SAFE Vpk check. Therefore, care should be taken to keep the drive level within safe limits for the system under test.

Once a suitable calibration signal level has been set up, allow the SUT to settle until the test average g equals the previously set grms, as indicated at the top of the display against AVG g and CAL rms g. Then press the ABORT key to complete the calibration.

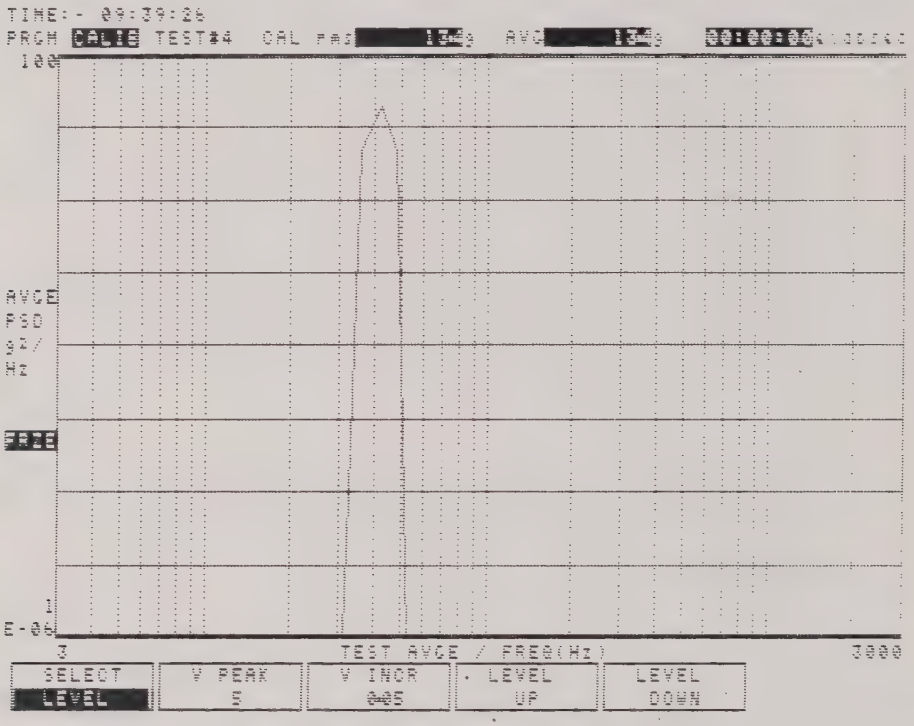


Fig. 3.5 *Selection of calibration LEVEL menu*

During the CALIBRATE process the ACCL SENS value in the SET INPUT menu and the DRIVE g/V value in the SET DRIVE menu are updated (see Figs 3.6 and 3.7). The input sensitivity (ACCL SENS) is calibrated by measuring the input acceleration (g PEAK) and calculating the scaling factor which makes this value equal to the CALIBRATE DRIVE g PEAK. The DRIVE sensitivity is calculated from the values of CALIBRATE DRIVE g PEAK and CALIBRATE LEVEL V PEAK.

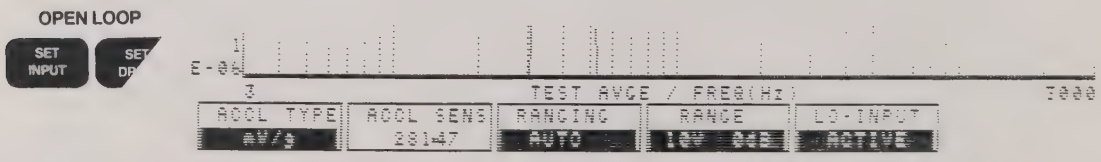


Fig. 3.6 *Selection of SET INPUT menu*

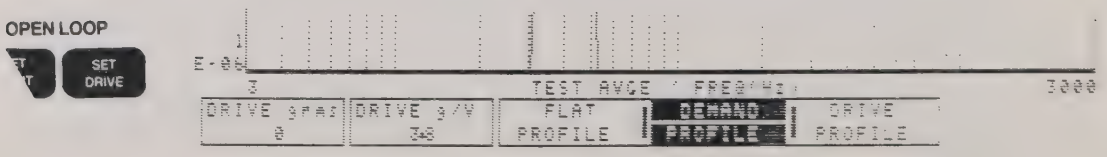


Fig. 3.7 *Selection of SET DRIVE menu*

For high Q systems, recalibration of the drive sensitivity may be necessary when first running the test. See Section 3.14.

3.5 ANALYSIS KEYS

The analysis keys, namely SET INPUT, SET DRIVE, SET ANALYSIS, and CALIBRATE, are grouped under the main heading OPEN LOOP on the keyboard. The keys and their associated menus are used to define the basic analysis parameters and system calibration when the controller is in ANALYSE or ABORT (3.4.1 and 3.4.5). In CLOSED LOOP the menus are automatically controlled and provide status information only.

3.5.1 Set Input

The SET INPUT menu allows the input system parameters to be defined. Two inputs are available, one (mV/g) for a voltage signal, as derived from an accelerometer via a charge amplifier, the other (pC/g) for a charge input directly coupled to the accelerometer. An accelerometer sensitivity factor, appropriate to the input selected, may also be defined, one factor being stored for each input type.

The input gain may be selected automatically (auto-ranging) or fixed by the user. Auto-ranging should be selected for CLOSED LOOP control, but in ANALYSE it may be more convenient to select a fixed range with the RANGE soft key. When auto-ranging is selected this key is disabled, but the menu box above it shows the range in use.

For the voltage input a differential configuration may be selected by allowing the Lo terminal to float (ACTIVE) or, if a single ended input is being used, the Lo terminal may be GROUNDED.

Differential inputs are recommended where it is required to minimise earth loop problems. Refer to Chapter 4, Section 4.1.3.

3.5.2 Set Drive

The SET DRIVE menu shows the status of the drive signal output to the system under test. Manual selection of these parameters is available in ANALYSE only.

DRIVE grms allows the selection of, or indicates, the acceleration level of the generator output. The voltage level required to generate this acceleration is derived from the drive sensitivity, selected, or indicated, by the DRIVE g/V soft key and is based on the calibration parameters (see CALIBRATE, Section 3.4.6).

The final three menu entries allow the selection of, or indicate the profile of, the drive spectrum and are mutually exclusive.

FLAT SPEC causes the generator to output band limited random noise, with a flat power spectral density over the frequency range 6Hz to 3kHz.

DEMAND PSD causes the generator output to be filtered according to the present demand psd profile defined by the PROGRAM, DEMAND PSD key (3.6.2).

DRIVE PSD generates the spectrum using the latest drive psd profile calculated in CLOSED LOOP.

3.5.3 Set Analysis

The SET ANALYSIS menu provides for the selection of the basic parameters used in the computation of the average psd data.

The channel (frequency) resolution is based on the overall controller bandwidth (6Hz to 3kHz) and the 500 line resolution, which gives 6Hz. It can, however, be advantageous to reduce this resolution – for example, to improve the control loop stability when

investigating systems with high 'Q' resonances or a non-linear response. The CHAN RESL soft key allows the resolution to be reduced from 6Hz to 12Hz or 24Hz, representing 500, 250 and 125 lines, respectively. (The term 'channel' is peculiar to the field of vibration analysis. It originated with analysers that used discrete filters and means the signal path taken through a single filter. In general frequency analysis terms, each frequency channel provides the data for a single spectral 'line'. Therefore channel resolution is equivalent to spectral resolution.)

The TEST DECAY softkey defines the time constant for the exponential averaging (fading memory) algorithm. As the time constant becomes longer, the test variance becomes lower. During the equalization process the averaging factor is varied automatically to give the desired run-up/run-down time constants. Once within the desired control limits the user defined decay rate is implemented, allowing the psd test variance to be set as required. It is necessary to note that a secondary effect of the averaging time constant is that it also affects the response time for any variation in the system under test. As a guideline a setting of 2 seconds gives a variance of ±1.5dB to a 90% confidence level, with a satisfactory response to external system variations.

The time constant is defined as the time in seconds taken to reach 63.2% of the final result for a step change in the input. If the time constant is denoted τ then the 'forgetting factor' (ρ) for the fading memory average is given by

$$\rho = 1 - \exp(^{-t}/_{\tau})$$

and the present average value (A_n) is calculated from the previous average value (A_{n-1}) and the current instantaneous value (a_n) by the relationship

$$A_n = (1-\rho)\, A_{n-1} + \rho\, a_n$$

The AVERAGE RESET softkey allows the average psd data to be cleared and a new average started. Since an rms average approaches the final result more quickly from zero than an exponential average, an rms averaging algorithm is used until the time constant has been reached. After this initial period of τ seconds the exponential averaging process takes over.

3.6 PROGRAM KEYS

The column of keys grouped under the main heading PROGRAM are used to define the vibration test parameters and limits.

3.6.1 Test Number

The TEST NUMBER menu identifies the PROGRAM and OPEN LOOP records to be selected from memory. The record selected provides the settings for the present test. The record is identified by entering a number, between 1 and 8 inclusive, with the numeric keypad and the TEST # soft key.

When a new test setting is required it is best to select the TEST # number to be used, and then to clear the test via the SELF TEST menu. This ensures that all test parameters are defaulted before the new test is set up.

Note that any new parameters entered for a test while it is in progress are implemented immediately and may cause an abort if gross changes are involved.

The recommended procedure for copying 'program' and 'open loop' settings from one test to another is as follows:

1. Clear the required test store (identified by the TEST # number).
2. Select the test store from which settings are to be copied, using the TEST NUMBER menu.
3. Reselect the test store selected in step 1.

This procedure copies all the test settings, except the psd and level sequence settings.

Editing of the DEMAND PSD or LEVEL SEQUENCE may be done using one of two presentations, MENU or TABLE, either of which is selected with the EDIT MODE key. The entries made when editing are 'live' and thus the display and test parameters are updated, as appropriate, on entry. It should be noted that some entries may cause the test to abort: therefore, it is advisable to edit test sequences in ABORT or ANALYSE.

The MENU edit mode allows entry of the test parameters, via the PROGRAM menus, in conjunction with the graphic display, which may be selected to show an appropriate plot (demand psd, alarm or abort limits). In ABORT the display is updated appropriately as the paramaters are entered; the psd scaling shows true psd amplitudes, as entered through the DEMAND PSD menu (3.6.2). In other control states the absolute psd amplitudes are scaled according to the demand grms presently selected. The CURSOR facilities (3.7.6) may be used as an aid in entering the required values.

In the TABLE edit mode the graphic display is deleted and the test parameters are shown on the CRT in tabular form. A maximum of ten lines of information may be displayed and each line contains the full definition of a demand spectrum segment or a demand grms level, depending on the menu selected. The line relating to the present setting of the menu is shown in reverse video. With a full screen of information displayed this line is maintained as the fifth one down, thus allowing the operator to view information preceding and following the present menu settings.

3.6.2 Demand psd

The DEMAND PSD menu allows the required drive frequency profile (the 'demand' profile) to be defined, together with the abort tolerances. The profile is defined in terms of frequency 'breakpoints' (where a change in the profile occurs) at which the psd value, or slope (rate of change of psd with frequency), and the abort limits are specified.

When defining a demand psd profile the following points should be remembered:

1. A minimum of two breakpoints is necessary to fully define a profile.
2. For the first breakpoint, i.e. the breakpoint at the lowest frequency, the amplitude must always be specified.
3. The slope is taken as being from the frequency considered, to the next frequency breakpoint, in dB/octave.
4. The amplitude and slope are interdependent and thus, if amplitudes are entered, the slope is automatically calculated.
5. The ABORT limit, specified in dB, applies from the breakpoint being set to the next breakpoint.
6. A breakpoint may be added to a demand profile by entering another FREQUENCY value regardless of the presently displayed frequency; each FREQ (Hz) value which has already been used recalls the breakpoint information stored for that frequency,

without a change to the profile. Initially, the breakpoint will be indistinguishable on the display, because the amplitude and slope are set automatically to ensure continuity between the breakpoints on either side. However, once the frequency value of the new breakpoint is entered, the amplitude and/or slope may be modified, as required, by entering new values.

7. A breakpoint may be deleted from a demand profile by first selecting the breakpoint, by frequency, and then entering a FREQUENCY value of zero.
8. The parameters of an existing breakpoint may be reviewed (in the soft key display) by selecting the frequency of that point, either with the STEP FREQUENCY key or by entering the appropriate FREQUENCY value.
9. Changing the slope of a breakpoint will alter the amplitude(s) of the following breakpoint(s) (i.e. all higher frequency breakpoints).
10. Changing the amplitude of a breakpoint will alter the slope to and from that breakpoint.
11. A 'SLOPE OUT OF RANGE' message means that the slope value last computed in accordance with another entry, is outside the permissible limits (which are normally ± 11,000 dB/octave). In this case, the value last entered should be amended.
12. Care should be taken not to exceed the permissible slope limits at low frequencies. The maximum controllable Q dictates that adjacent lines (or 'channels') may not have a demand psd difference of >2dB, approximately. This means, for example, that the slope between the frequencies of 6Hz and 12Hz must not exceed 2dB/octave.
13. Accuracy of upper abort limit = 0.1dB;
    accuracy of lower abort limit = ± 1db at 20dB (maximum error).

'DEMAND g' provides status information only and does not permit numeric entry. It shows the total rms acceleration level for the demand profile, expressed as the square root of the sum of all the channel powers between 6Hz and 3kHz. Thus,

$$\text{DEMAND } g = \frac{1}{500}\sqrt{\sum_{n=1}^{500} g_n^2}$$

The total rms drive acceleration actually used in the test is specified in the LEVEL SEQUENCE MENU (3.6.3) and, if the absolute values entered at the breakpoint frequencies need to be used, the DEMAND g figure should be noted.

The STEP FREQ soft key allows the DEMAND PSD parameters to be reviewed. When used in conjunction with one of the 'shift' keys the STEP FREQ key scrolls back through the series of profile parameters. When used on its own a forward scroll is obtained.

3.6.3 Level Sequence

The LEVEL SEQUENCE menu may be used to specify up to ten overall drive acceleration levels, together with the abort limits, and the time period for which each level is to be applied to the SUT. Each level is identified by a reference number (LEVEL #) between 1 and 99. The levels are selected in numeric order and can be changed and deleted if necessary. By not using consecutive reference numbers, e.g. 10, 20, 30, etc, it is possible to insert an extra level into the sequence at a later date.

The grms key allows the total acceleration level required for the test to be input via the numeric keypad. Remember that, if the absolute breakpoint psd values used in the DEMAND PSD menu are to be applied, the DEMAND g value must be input.

The time for which an acceleration level is to be applied is entered under PERIOD. Any value between 0 and 32000 seconds can be specified and includes the transition time from the previous level to the new one.

Note that 0 represents an infinite time period and is used where a given level is to be applied with no time limit. If a finite time period greater than 32000s is needed then more than one LEVEL SEQUENCE may be defined with the same grms. ABORT % is a protection aid to stop the test if the overall acceleration level (grms) exceeds a limit, specified as a percentage of the grms value. This limit has a default value of 200%, although a value between 100% and 1000% may be specified.

3.6.4 Protect Limits

This key accesses two parameters associated with overall system protection, which avoid overtesting and consequent damage to the SUT. The parameters are applicable during CLOSED LOOP operation of the controller.

The ALARM % key allows a tolerance band within the ABORT dB limits specified in the DEMAND PSD menu. The alarm level is expressed as an integer percentage, between 1% and 100%, of the ABORT dB limit and applies to all demand psd segments. If the alarm level is exceeded, an audible warning is given and an appropriate error message is shown on the display. The test will, however, not be affected, as this is a warning signal only.

The ABRT COUNT key is used to specify the number of frequency channel levels that are permitted to exceed the ABORT dB limits before execution of the ABORT function. This parameter is useful when non-linearities or spurious acceleration levels above the abort limits are known and can be tolerated. A value of 1 will cause the test to abort immediately any channel exceeds the limit and a value of 501 is a dummy figure which effectively switches the limit function off.

The abort count allows the control confidence level to be set. Since the control signal is random, its characteristics (psd amplitudes) can only be estimated. Having defined the alarm and abort amplitudes, therefore, it is necessary to specify the level of confidence within which these values are expected to occur. If, for example, 500 control channels have drive defined, an ABORT COUNT of 50 implies a 90% confidence level, and, for this to be achieved, there must be <50 channels outside the amplitude limits.

3.6.5 Drive Limits

This menu is mainly associated with the drive signal requirements during closed loop control, although the parameters also apply to operation in ANALYSE.

RUN LOW % defines the signal level that is used in RUN LOW (3.4.2) to equalize the test acceleration. It is expressed as an integer percentage of the initial grms value defined in the present LEVEL SEQUENCE.

CREST FCTR limits the peak level of the drive signal to optimise the peak to rms voltage, or acceleration, ratio (crest factor). This reduces the likelihood of overloading the SUT and the excitation of a non-linear response. The clipping is achieved by an arithmetic algorithm that minimises degradation of the amplitude probability density function and spectral distortion.

RUN UP AND RUN DOWN define the time period, in seconds, during which the drive level will change smoothly from one level to another; for example, during LEVEL SEQUENCE control, or when changing from RUN LOW to RUN HIGH. The transition period is entered as an integer number of seconds between 1 and 100 and the acceleration change is logarithmic.

The periods selected for RUN UP and RUN DOWN do not affect the ABORT shut down, for which the transition period is fixed.

SAFE V PK defines a maximum safe drive signal, which can be tolerated in any of the drive states; this avoids the overloading of any part of the SUT. The voltage specifies a clipping limit, and invokes the crest factor control algorithm to restrict the signal amplitude.

3.7 DISPLAY AND CURSOR CONTROLS

Status and measurement information from the RVC is displayed on a 230mm (9ins) raster scan CRT and comprises:

- ★ machine status and other on-line information,
- ★ a graph of the measurement,
- ★ the last selected soft key menu.

The display format is shown in Fig 3.8.

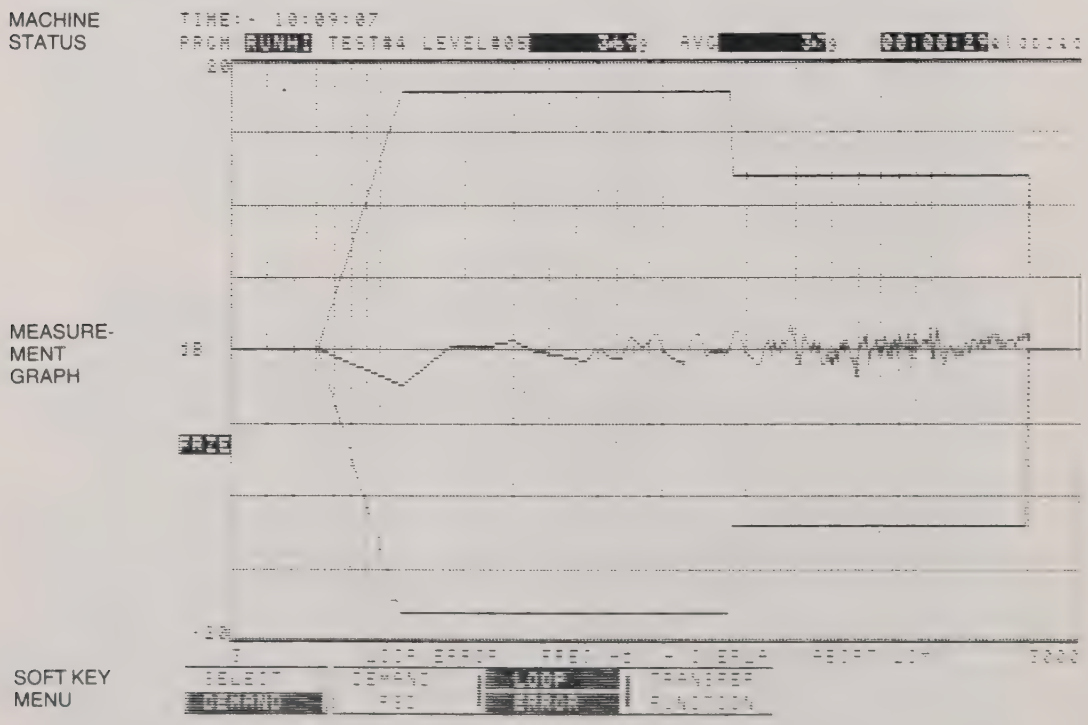


Fig. 3.8 *RVC Display format*

The graphics area includes full axis annotation and cursor and graticule facilities. It is also possible to display alphanumeric information in place of a graphic display, by selection of the STATUS menu (3.7.7) or the TABLE EDIT MODE in the TEST NUMBER menu (3.6.1).

The following data are displayed on the two 'status' lines at top of the display:-

Clock Time

Control state (as defined in section 3.4)

Test and level sequence numbers presently selected

grms demand level (present required acceleration level)

grms test level (present smoothed acceleration level)

Elapsed time at present grms demand level

Cursor data

Operator message (a message, highlighted by a flashing indicator, which overwrites clock time; see Section 3.13).

Details of the status information layout are given in section 3.7.8.

The MAIN information (3.7.1) which may be displayed graphically comprises:-

i)	Test signal	:	time domain instantaneous psd average psd
ii)	Demand signal	:	demand psd loop error transfer function
iii)	Drive signal	:	time domain drive psd

By the use of the OVERLAY facility (3.7.2), the MAIN graphics information may be viewed in conjunction with an overlaid display of:-

i)	LIMITS	:	alarm or abort limits
ii)	PSD	:	test signal psd (instantaneous or average) demand psd drive psd

The overlaid graph must, of course, be compatible with the MAIN graph, otherwise it will not be displayed.

3.7.1 Main

The MAIN key has three associated menus to enable selection of TEST, DEMAND or DRIVE signal data. The selections are mutually exclusive, i.e. only one may be displayed at a time. When the MAIN key is pressed the menu displayed is the one containing the present main graph selection.

Signal amplitudes in the time domain are displayed in units of 'g', which are scaled as follows:

For the TEST signal (TEST TIME), according to the input sensitivity (see SET INPUT menu, Section 3.5.1),

For the DRIVE signal (DRIVE TIME), according to the drive sensitivity (see SET DRIVE menu, Section 3.5.2).

The DEMAND LOOP ERROR is a measure of the error between the required demand psd and the actual test psd and is defined as:

$$\text{Loop error} = \frac{\text{Test average psd estimate}}{\text{demand psd}}$$

The DEMAND TRANSFER FUNCTION relates the input to an output from the SUT, using the relationship:

$$\text{Transfer function} = \frac{\text{Test average psd}}{\text{drive psd}}$$

When operating in open loop the transfer function and loop error will be the same.

The loop error and transfer functions are defined only in the area where the demand psd is defined. In undefined areas the functions are shown as 0dB. Both functions can be scaled only in dBs.

3.7.2 Overlay

The OVERLAY facility allows two compatible displays to be overlaid, for direct comparison. The menu selections are mutually exclusive. The limit displays show the limits associated with the DEMAND PSD profile (3.6.2) and the PROTECT LIMITS parameters (3.6.4). If the displayed function and overlaid function are incompatible (e.g. TIME and PSD) the OVERLAY is automatically switched off and the selected MAIN display only is shown. If a compatible display is then selected the OVERLAY FUNCTION is automatically brought back. Overlaid functions may also be displaced vertically, relative to each other, to improve clarity, as described in section 3.7.3.

3.7.3 Scale

Two menus are associated with the SCALE key: UNITS AND SCALING.

The UNITS menu has four associated soft keys which allow the horizontal and vertical axis calibration to be specified.

The UNITS, FREQ AXIS soft key allows the frequency (horizontal) axis to be scaled linearly from 0Hz to 3000Hz, or logarithmically, in whole decades of frequency, from 3Hz to 3000Hz.

The UNITS, DATA AXIS allows psd function data to be displayed in units of log dB, g^2/Hz or g/$\sqrt{}$ Hz, with the 0dB reference level for g^2/Hz being entered via the LOG REF key.

UNITS, OFFSET % permits an overlaid graph to be offset vertically, relative to the MAIN graph, to clarify a comparison between two similar traces. The offset is defined as an integer percentage of the vertical axis scale length and can take a value between 0% and ±100%. When offset is selected, 'OFST' appears in reverse video in the position shown in Fig 3.9.

The SCALING menu defines the data (vertical) axis calibration. When MODE AUTO is selected the display is scaled automatically to ensure the best view of the function data. A nominal 80dB range is displayed. In the MODE FIXED format the user defines the range, by specifying the axis minimum (DATA MIN) and the range (DATA RANGE). For functions dimensioned in units of g/$\sqrt{}$ Hz and g^2/Hz the RANGE soft key defines an integer number of decades, otherwise an absolute axis range is entered.

3.7.4. Freeze

Pressing the FREEZE key 'freezes' the current display, including all annotation, and is used when a video hard copy of the display is required. The key has no associated menu and pressing once causes the display to be held immediately; pressing a second time allows the display to be updated again. Operation of the key is indicated by FRZE appearing against the left hand axis, as shown in Fig 3.9.

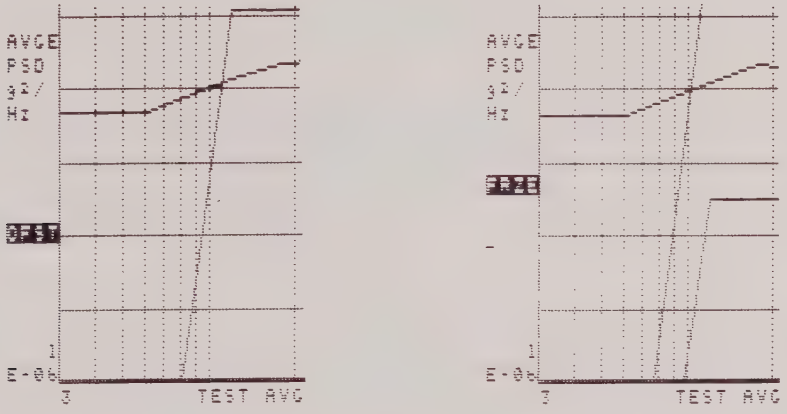


Fig. 3.9 *Position of OFST (offset) and FRZE (freeze) legends on display.*

3.7.5 Plot

The PLOT key accesses the digital (GPIB) and analogue plotting facilities and calls up three menus for setting up and controlling a suitable plotter.

The FORMAT menu provides for the definition of:

- ★ the plotter type (ANALOGUE or GPIB),
- ★ the paper size (A3 or A4)
- ★ the plotting speed (FAST, MEDIUM, SLOW) (Analogue plotters only),
- ★ plot annotation, on/off.

The annotation available comprises the axis labelling and includes the title of the function being plotted, the scaling and the maximum and minimum axis values.

The graticule may be plotted or not, in accordance with the GRATICULE ON/OFF selection.

Axis scaling may be re-defined if required, via the SCALING menu, by specifying the axis minima and maxima. The procedure is as follows:

1. Select PLOT ZERO with the PLOT CONTROL menu.
2. Select X MIN with the PLOT SCALING menu and define the VALUE. The value is defined either by a direct entry from the numeric key pad or by defining an INCREMENT value and using the INCREASE and DECREASE keys to step to the X MIN value.

3. Repeat Step 2 for Y MIN.
4. Select PLOT FULL SCALE with the PLOT CONTROL menu.
5. Repeat Step 2 for X MAX and Y MAX.

Steps 1 and 4 are necessary only when it is required to see the pen movement on the platten. When setting up the graph position remember to allow space on the platten for the annotation.

The PLOTTER CONTROL menu is also used to START and STOP a plot.

Whilst a wide range of analogue plotters may be used with the RVC, a strict specification exists to ensure the compatibility of digital plotters with this instrument. A digital (GPIB) plotter must use the Hewlett Packard Graphics Language (HPGL) and must also be capable of being switched manually to 'LISTEN ONLY'. If the latter requirement can not be met it is possible to command the plotter to be a 'LISTENER', but a suitable controller must be used.

The digital plotter is connected to the GPIB (IEEE 488) interface connector on the rear panel of the RVC and the interface switched to 'TALK ONLY' by selecting FUNCTION switch 5 to ON. Note that if an interface switch position is changed it will be necessary to initialise the RVC (Section 3.9) or power down and power up again to enable the new switch settings to be read. The GPIB status may be reviewed by selecting the GPIB status page (Section 3.7.7).

The analogue plotter is connected to the RVC via a 15-way Cannon connector, wired as described in Chapter 4, Section 4.1.7.

3.7.6 Cursor and Graticule

The CURSOR facilities allow the user to establish values for the displayed data. Of the five hard keys associated with the cursors, the upper two define the cursor type, horizontal or vertical, while the lower three control cursor movement. The values at the cursor intercept are presented at the top of the display, as shown on page 3.19, once the cursor is positioned within the range of the instrument.

The vertical cursor (selected by the key marked with a vertical bar) reads data from the function data store to its full measurement precision. The cursor runs through all the data (from 6Hz to 3kHz) and each press of a cursor movement key (marked with an arrow) causes the cursor to move to an adjacent frequency channel in the direction indicated.

The horizontal cursor (selected by the key marked with a horizontal bar) moves by an amount equal to the vertical resolution of the display for each cursor movement key press. The displayed value is calculated from the position of the cursor, relative to the axis minimum and maximum values, with a precision of 1/200 of the range resolution. Thus, if absolute values are required, the vertical cursor should be used. Note that, when using the horizontal cursor, the right pointing arrow moves the cursor upwards and the left arrow moves it downwards.

A single press of a cursor movement key (← or →) causes the cursor to move an amount equal to the resolution of that cursor. The keys are, however, auto-repeating and sustained pressure will cause a continuous movement. Rapid cursor movement is achieved by pressing the cursor movement key in conjunction with the FAST key.

The CURSOR type keys access a single soft key menu which enables the GRATICULE to be switched ON or OFF. In some cases the cursor position may be seen more clearly by switching the GRATICULE off.

3.7.7 Status

The STATUS hard key accesses five mutually exclusive menu functions. These allow alphanumeric status information to be shown in place of the graphic display, but do not interrupt the measurement and control functions.

A sixth soft key, 'CLEAR ERRORS', cancels the error messages stored on the error status page and thus enables the user to distinguish between previous and subsequent errors.

GPIB displays the system parameters associated with the GPIB (IEEE 488) Interface and the state of the interface.

TEST DEFINITION shows the status of the battery backed CMOS store which contains the demand psd and level sequence data, and checks the data validity.

The ERROR soft key recalls the latest error message (which appears momentarily during the graphic display) and also allows data limits for numeric entry keys to be determined.

SYSTEM STATUS displays the present status of the RVC system. The information comprises:

INTERLOCK STATUS	Status of DRIVE REQUEST/READY signals: ABORT or REQUEST/READY or NOT READY.
SELECTED INPUT	VOLTAGE, CHARGE, TEST VOLTAGE or TEST CHARGE, as selected with the INPUT keys in the SELF TEST and SET INPUT menus.
CALIBRATION LINKS	Normally the links are OUT; the links are selected IN with an internal switch for maintenance purposes.
ABORT COUNT	Reflects the value set into ABORT COUNT in the PROTECT LIMITS menu.
ABORT CHANNELS OOB	The number of channels (lines) whose psd amplitude is outside the abort limits.
ALARM CHANNELS OOB	The number of channels whose psd amplitude is outside the alarm limits.
RUN LOW %	Reflects the RUN LOW % value set in the DRIVE LIMITS menu.
LEVEL SEQUENCE	The number of the level selected by the present test. Will indicate 'UNDEFINED' if no levels have been defined for the test.

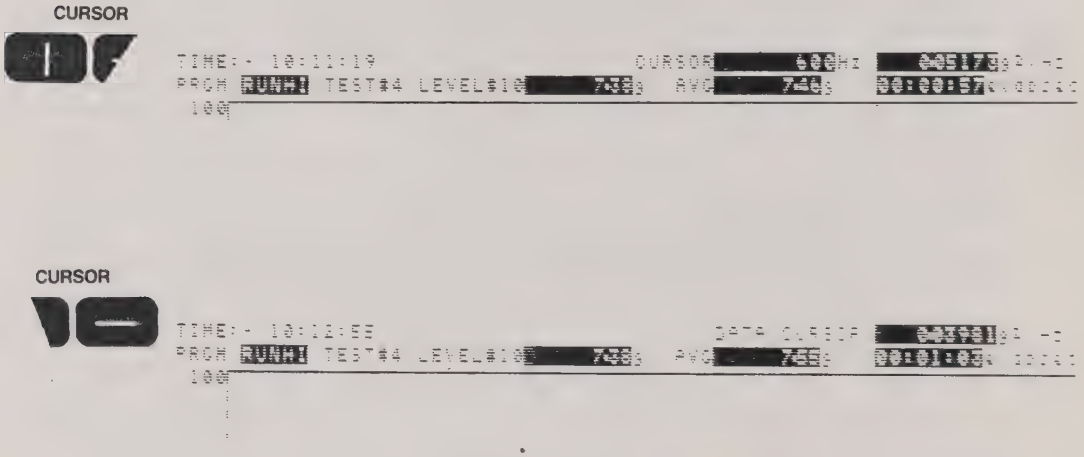
Pressing the OFF key returns the user to the graphic display shown prior to the STATUS page being selected. Pressing MAIN leaves the STATUS page selected and restores the graphic display.

3.7.8 Display Status Lines

The two status lines at the top of the display show the operational status of the instrument, the time (which may be programmed to show time of day), and the cursor information. The time shown is either the time elapsed since power-up or, if it has been set from the keyboard, the time of day. This information is occasionally overwritten by any operator messages that may occur.

If either of the cursors is in use the appropriate cursor information will also be displayed.

The two formats for the status lines, including cursor information, are:



where the units are automatically selected to be compatible with the display.

The second line, showing the operational status has a number of alternative entries. These are tabulated below, with additional explanatory notes indicated by superscripts.

PRGM[1]	ABORT[3]	TEST#n[4]	LEVEL#nn		g[5]	AVG		g[9] hh:mm:ss elapsed[10]
LOC[1]	RUNHI		DRIVE		g[6]			
REM[1]	RUNLO		DEMAND		g[7]			
EXT[2]	ANLYS		CALrms		g[8]			
	HOLDA							
	HOLDL							
	HOLDH							
	CALIB							

Notes:

1 Control State — Defines the front panel keyswitch selection when operating under keyboard control (3.3).

2 Control State — Shows that the RVC is operating under computer control, independently of the keyswitch setting.

3	Control State	Shows the major control state key selection (3.4). The 'A', 'L' and 'H' after HOLD indicate the state of the RVC when the HOLD key was pressed: A – ANALYSE L – RUN LOW H – RUN HIGH CALIB indicates selection of the CALIBRATE key (3.4.6).
4	TEST#n	The Test number.
5	LEVEL#nn	Indicates the level sequence reference number when operating in CLOSED LOOP. The appropriate demand level (grms) is shown in reverse video (3.6.3).
6	DRIVE	Indicates the acceleration level (grms) when operating in ANALYSE. This value corresponds to the SET DRIVE, DRIVE grms setting (3.5.2).
7	DEMAND	When the RVC goes into ABORT either 5 or 6 above will continue to be displayed. If, however, a test parameter is changed the previous test data are cleared and the DEMAND PSD, DEMAND g value is shown. This gives a display of the demand psd profile, scaled to show the user selected segment levels.
8	CAL rms	The required grms to be measured at the system under test during calibration.
9	AVG	Indicates the average response (test) acceleration level (grms) measured over the selected bandwidth.
10	elapsed	Shows the time elapsed since RUN HIGH was selected. The total time is shown, including the time taken to ramp up or ramp down to the test level.

3.8 NUMERIC ENTRY

Some functions require the user to enter a numeric value. For each of these, a prompt character (?) appears in the appropriate menu box after the relevant soft key is pressed. The value is entered with the numeric keypad on the main keyboard.

Values may be entered in fixed point or exponential format and for positive values the sign need not be defined. For negative values the +/− sign reversal key is pressed once prior to entering the first digit. Entry of the exponent, when using exponential format, is preceded by pressing the E EX key, followed by, if appropriate, the sign reversal key. Each value keyed in appears in reverse video to the left of the '?' character.

Before a number is entered it should be checked for errors. These can be corrected using the BACKSPACE or CLEAR keys. Each operation of the BACKSPACE key deletes one character, starting with the last character entered and working back to the first. The CLEAR key deletes all keyed characters simultaneously and allows the user to start again.

Having checked and, if necessary, corrected a value the ENTER key is pressed and the value entered. A valid value is then presented in normal video to signify acceptance. If an invalid value is entered then an appropriate error message is displayed and the previous value is retained. To re-access the numberic keypad the relevant soft key should be pressed again and the above process repeated.

3.9 SELF TEST

The self test key has three associated menus, SELF TEST, INIT STORE and SET TIME.

SELF TEST provides a POWER UP TEST and SYSTEM CHECK. These two functions enable the operator to check that the RVC is functioning correctly. On completion of either function the instrument is set to it's initial control state. The instrument may be initialised without a function check by the use of the SYSTEM INITIALISE key.

Also provided in SELF TEST is a key to select the TEST inputs. If a test input is selected the drive output is connected internally to the relevant input, voltage or charge. When the test input is no longer required the appropriate external signal source should be selected. This automatically reselects the correct units, mV/g or pC/g, in the SET INPUT menu.

Initialisation returns the display and CURSOR functions to their default states, but retains the test parameters stored in the non-volatile memory. Thus the PROGRAM and OPEN LOOP parameters are retained and the previously set test is recalled.

NOTE: THESE FUNCTIONS CAUSE THE GENERATOR VOLTAGE TO REVERT TO OV IMMEDIATELY.
THE SELF TEST FUNCTIONS SHOULD BE USED ONLY WITH THE RVC IN ABORT.

The INIT STORE menu allows the operator to delete the presently selected test parameters prior to entering new ones. The TEST#n key provides for the clearance of individual tests, whilst the 'CLEAR ALL TESTS' key clears them all. The test number displayed above the TEST#n key when the INIT STORE menu is selected is that of the present test, but this can be overwritten by a numeric entry.

The SET TIME menu permits entry of the time of day, using the numeric keypad. The time is updated as each number is ENTERed.

3.10 'rtl' KEY

The rtl (return to local) key overrides the remote status and allows manual control via the keyboard, subsequent to use of the RVC with a GPIB controller. This key may be disabled by selecting Local Lockout (LLO) from an external controller.

3.11 CONTROL KEYSWITCH

A key operated, three position switch is provided on the front panel to allow the RVC to be set into its basic operating state, 'Program', 'Local', or 'Remote'.

'Program' allows access to all front panel functions to define test parameters and to provide full front panel control of the test.

'Local' inhibits the PROGRAM, OPEN LOOP and self test keys. All display and cursor keys are operational. The CLOSED LOOP key group may be used to run vibration tests.

'Remote' inhibits the PROGRAM, OPEN LOOP, CLOSED LOOP (except ABORT) and self test key groups. All display and cursor keys are operational. The RVC may be commanded to run vibration tests, with the 'Drive Request' interlock signal.

Under EXT control via the GPIB all keys are inhibited; except 'rtl', which may be inhibited also by the use of 'local lockout'.

3.12 INTERLOCK

The interlock facility provides for 'handshake' communication between the RVC and the system under test (SUT). An RVC READY signal is sent to the SUT when the RVC is ready for an operation command such as ANALYSE or RUN HIGH. A reciprocal DRIVE REQUEST signal must be received back from the SUT before the command can be implemented.

The use of the interlock facility is illustrated in Fig 3.10. In the simple example shown, the 'ready' state of the RVC is indicated by the lamp. A drive request is made by closing the external switch.

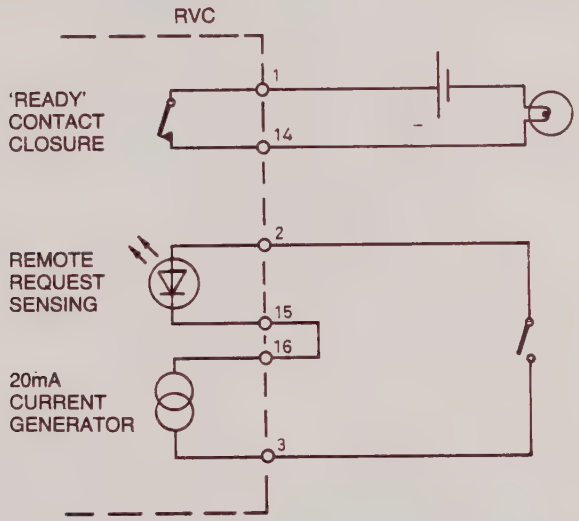


Fig. 3.10 *Interlock connection example*

The RVC READY signal is given via a contact closure, which allows connection to the SUT in a series ring. While the RVC is not ready the contact is open. This means that the system is fail-safe; the RVC will not operate if the cable connection is lost. The RVC READY output is potential-free, but may be made active by connecting it in series with the 20mA current source that is included in the RVC.

The DRIVE REQUEST input must be driven by a 20mA current source, such as the one included in the RVC. The loss of the DRIVE REQUEST signal whilst an RVC operation is in progress causes the instrument to enter the abort state: the drive signal to the SUT is reduced smoothly to 0V and the message 'ABORT: TEST TERMINATED EXTERNALLY' is displayed.

The interlock facility will work with the RVC in any operating status: 'program', 'local', 'remote', or 'external'. In 'remote' the DRIVE REQUEST signal will actually start a test, being equivalent in this case to a RUN HIGH command.

For the RVC to operate, the interlock signals must be asserted in the correct sequence. This sequence is shown in the timing diagram of Fig 3.11. The significance of the interlock signals is described below.

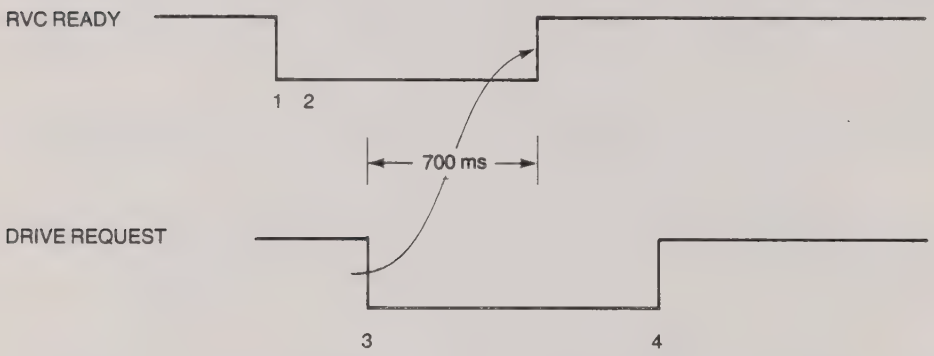


Fig. 3.11 *Interlock signal timing.*

Interlock signal sequence:

1. The RVC aborts or terminates a test and opens the RVC READY contacts.

2. The RVC READY contacts remain open until the DRIVE REQUEST signal is negated.

3. DRIVE REQUEST negated. The RVC will now close the RVC READY contacts when it is able to start a new operation.

4. DRIVE REQUEST asserted. The RVC will now accept an operation command, such as ANALYSE or RUN HIGH.

If it is required simply to abort an RVC operation, the DRIVE REQUEST signal should be negated for approximately 100ms; the RVC will then go to the abort state, and will remain so, with the RVC READY contacts open. To abort an operation and restart, the DRIVE REQUEST signal should be negated, then asserted after a delay of >700ms, as shown above. The delay covers the abort sequence, on completion of which the RVC will be ready (RVC contacts closed) for the next command.

Operation of the RVC without an external interlock requires the READY and REQUEST terminals to be linked at the rear terminals, as shown in Fig 3.12.

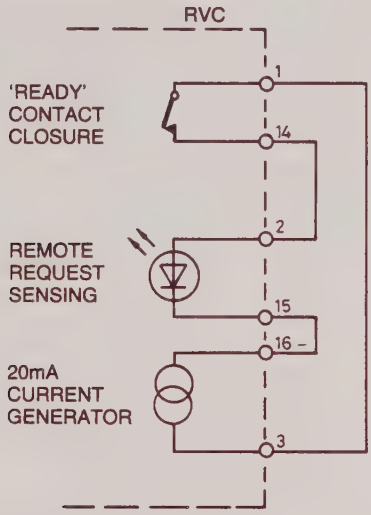


Fig 3.12. *Interlock dummy connections*

3.13 OPERATOR MESSAGES

Various messages to the operator are presented momentarily at the top of the display whilst the RVC is being set up or is running a test or an analysis. A message may be a warning, an error message, or an abort message, as identified by the flashing indicator displayed against it, i.e. '*******', 'ERROR', or 'ABORT'. The last error message presented, and the error message previous to that, may be reviewed on the ERROR status page, as may the last warning and the last abort message. The meaning of each message and its code (in brackets) are given below:

DRIVE LIMIT AT SAFE V PEAK (Warning 101)	Drive peak output voltage is limiting at the SAFE V (pk) value specified in the DRIVE LIMITS menu. This may cause spectral distortion.
SLOPE OUT OF RANGE (Warning 102)	Slope outside permissible limits (± 11,000 dB/octave).
TEST CLEARED (Warning 103)	Currently selected test has been cleared.
ALL TESTS CLEARED (Warning 104)	All tests (1 to 8) have been cleared.
ALARM, PSD OUTSIDE LIMITS (Warning 105)	Drive psd outside alarm limits on one or more channels. The number of channels out of limits is shown on the SYSTEM status page.

INPUT OVERLOADED (Error 200)	Signal amplitude too high on FIXED range, or >10V, or transiently high, on AUTO range. This error can give rise to spectral distortion or to control loop problems.
COMMON MODE/HF OVERLOAD (Error 201)	Input amplifier overloaded, due to a common mode signal >30V or to a frequency component >3kHz. Same comment as for Error 200 above.
SET AMPLITUDE (Error 203)	Amplitude of first breakpoint not set.
NO FREE BREAKPOINTS (Error 204)	An attempt has been made to define more than 100 breakpoints + levels; see TEST DEFINITION status page.
10 LEVELS SPECIFIED (Error 205)	An attempt has been made to define more than 10 levels for one test.
SELECT ABORT (Error 206)	An attempt has been made to select CAL in a control state other than ABORT.
VALUE FIXED (Error 207)	An attempt has been made to adjust the plotter scaling whilst the scaling is FIXED.
PLOT LIMITS INCOMPATIBLE (Error 208)	An attempt has been made to select invalid plotter scaling, e.g. min > max.
NO INTERLOCK REQUEST (Error 209)	An attempt has been made to operate the instrument without an interlock DRIVE REQUEST.
NOT ACTIVE IN LOCAL (Error 210)	At attempt has been made to operate a key that is not enabled in LOCAL.
NOT ACTIVE IN REMOTE (Error 211)	At attempt has been made to operate a key that is not enabled in REMOTE.
SYSTEM TEST FAILURE (Error 212)	A failure has occurred in the main RVC data processing area. For further information do a SYSTEM CHECK via the SELF TEST menu.
INTERFACE TEST FAILURE (Error 213)	A failure has occurred in one of the RVC interface modules, i.e. the GPIB Interface, the Plotter Interface or the Keyboard Interface. For further information do a SYSTEM CHECK via the SELF TEST menu.
NUMBER OUT OF BOUNDS (Error 214)	An attempt has been made to enter a number that is out of bounds.
NUMERIC ENTRY IGNORED (Error 215)	A key, other than a number key, has been operated during a numeric entry.
LOCAL LOCKED OUT (Error 216)	An attempt has been made to operate the rtl (return to local) key whilst local lock out is selected.

NOT ACTIVE IN EXT MODE (Error 217)	At attempt has been made to operate any key, other than the rtl key, whilst the RVC is operating under EXTernal (remote) control.
OPEN LOOP (Abort 301)	Insufficient response, at the input, to the drive. Test aborted.
DRIVE OUT OF BOUNDS (Abort 302)	At attempt has been made to drive the generator at >10V peak. Test aborted.
PSD OUTSIDE LIMITS (Abort 303)	Psd outside abort limits for a greater number of channels than that specified in ABORT COUNT in the PROTECT LIMITS menu. The number of channels out of limits is shown on the SYSTEM status page.
grms LIMIT EXCEEDED (Abort 304)	The grms limit, as defined by ABORT % in the LEVEL SEQUENCE menu, has been exceeded. Test aborted.
LEVEL SEQUENCE COMPLETE (Abort 305)	A test sequence, defined for a finite period, has been completed.
TERMINATED EXTERNALLY (Abort 306)	External request removed during test. Test aborted.
grms NOT DEFINED (Abort 307)	The drive grms has not been defined for the present test. Test aborted.

3.14 RECOVERY FROM FAILURE TO EQUALISE

Equalisation of the system response with the demand profile may sometimes fail to occur. Assuming that the RVC has been calibrated, the failure to equalise is generally due to a condition of the system under test.

Insight into which particular condition is causing the problem may be obtained by looking at the transfer function and the test signal, with the RVC in ANALYSE.

Of the various types of system that may cause equalisation problems, three are encountered quite frequently: high Q systems, systems with high resonant frequencies, and non-linear systems. Each of these system types is discussed below.

Often, a failure to equalise will cause the RVC to abort the test. This state will be indicated by an abort message, which shows whether the failure to equalise was caused by the system response (AVG g) being too low in amplitude, or too high. While a test is proceeding a continuous check is made of the ratio instantaneous grms/DRIVE grms (system gain): if this ratio is <0.5 then the message 'ABORT: OPEN LOOP' is displayed. A check is also made on the grms value: if this is greater than grms × ABORT %, as defined in the LEVEL SEQUENCE menu, then the message 'ABORT: grms LIMIT EXCEEDED' is displayed.

3.14.1 Equalisation with High Q Systems

In CALIBRATE the RVC uses a single frequency. Hence, in the case of a high Q system it is possible to calibrate a test at a resonant, or anti-resonant, frequency. A drive sensitivity value thus obtained is unrepresentative of the system under test over the test frequency band and consequently the test may be aborted. Generally an abort for high Q systems occurs on RUN LOW. The operator message displayed will be either:

a) 'ABORT: OPEN LOOP', for calibration at a resonant frequency, or

b) 'ABORT: grms LIMIT EXCEEDED', for calibration at an anti-resonant frequency.

Recovery from either condition may be achieved by recalibrating the drive sensitivity only, using the following procedure:

1. Note the values for 'AVG g' (at the top of the display) and the values for 'DRIVE grms' and 'DRIVE g/V' (in the SET DRIVE menu) and calculate a new value for DRIVE g/V:

$$\text{DRIVE g/V} = \text{DRIVE g/V} \times \frac{\text{AVG g}}{\text{DRIVE grms}}$$

2. Enter the new DRIVE g/V value thus obtained and restart the test.
3. Repeat steps 1 and 2, as necessary, until the values obtained for AVG g and DRIVE grms are approximately equal, when the test should run successfully.

Equalisation may be further improved by decreasing the channel resolution via the SET ANALYSIS menu.

3.14.2 Equalisation with Systems Having High Resonant Frequencies

For systems with resonances at high frequencies the crest factor of the drive signal should not be set too low. This is because any clipping of the drive signal in line with crest factor control will result in energy from harmonic components being applied at the upper frequencies and will aggravate the equalisation problem. If equalisation does not occur once the crest factor is set then the next step is to increase the ABORT COUNT value, via the DRIVE LIMITS menu, and to accept the excursions. The number of channels outside the ABORT dB limits for the present test is shown on the ERROR STATUS page.

An abort on failure to equalise, for systems with high resonant frequencies, generally occurs on RUN LOW. Equalisation can be poor without causing an abort for this type of system, but is apparent in the resonant peaks at the high end of the spectrum.

3.14.3 Equalisation with Non-linear Systems

An 'ABORT grms LIMIT EXCEEDED' condition can occur, on RUN HIGH, if the system under test is non-linear. The cause is that the spectrum of a non-linear system varies with the drive level and therefore, if the drive run up time is too short, the RVC will attempt to equalise over too great a difference in signal level. The cure is to increase the drive RUN UP time in the DRIVE LIMITS menu, thus slowing down the rate of change in the system response and allowing the RVC to track the amplitude changes.

Non-linearity can be determined in 'open loop' by checking the system transfer function at suitable 'low' and 'high' levels and comparing the two results. A non-linear system will exhibit changes in the profile as the excitation level is increased.

Chapter 4
Installation

CONTENTS

		Page
4.1	External Connections	4.1
4.2	Accessories	4.5
4.3	Ventilation	4.5
4.4	Rack Mounting	4.6

CHAPTER 4 INSTALLATION

4.1 EXTERNAL CONNECTIONS

All external input and output connections are made on the rear panel, as described in Sections 4.1.1 to 4.1.7. A view of the rear panel is shown in Fig 4.1.

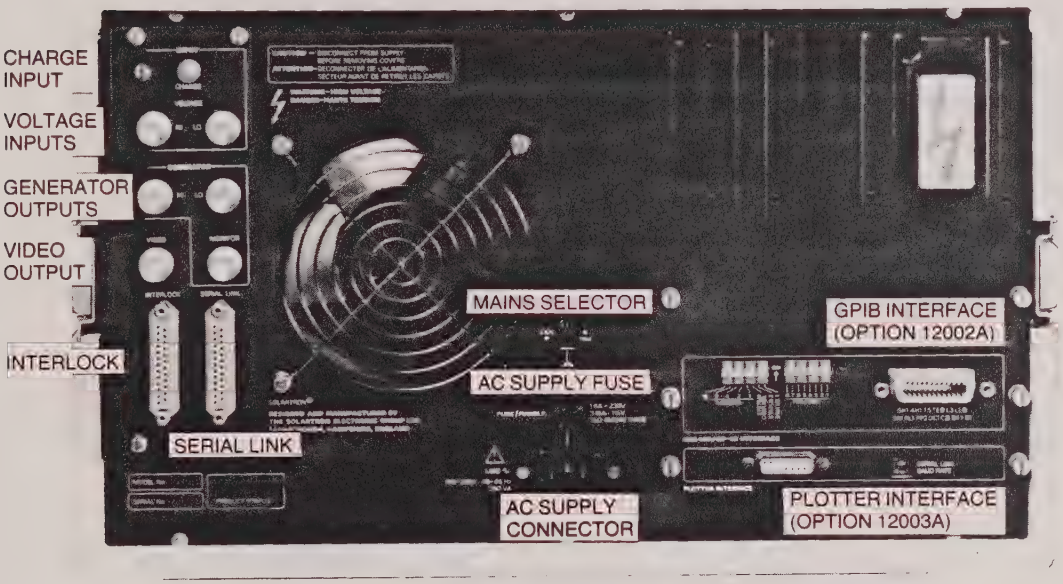


Fig. 4.1 *Rear panel of RVC*

4.1.1 Mains Input

An ac supply cable, with a suitable connector at either end, is supplied with instruments destined for the following countries:

U.K.	(Part No 359900380)
Europe	(Part No 359900250)
USA and Canada	(Part No 359900390)

For all other countries, the ac supply cable (Part No 480140220) has a moulded IEC socket on one end only, for mating with the IEC plug on the RVC. This cable should be connected to the user's ac supply in accordance with the following colour code:

BROWN: LINE, BLUE: NEUTRAL, GREEN/YELLOW: EARTH

If the user already has a supply cable terminated with an IEC socket then this can be plugged directly into the ac supply plug on the rear panel, provided that the socket is wired as shown in Fig 4.2.

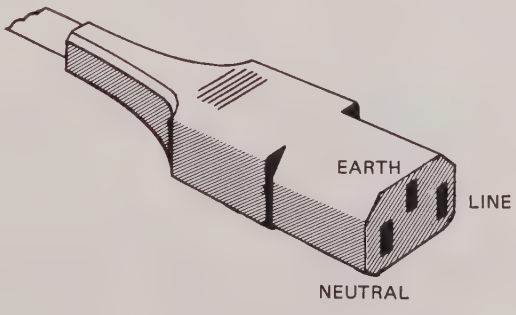


Fig. 4.2 *IEC power socket connections*

Ensure that the mains selector is set in accordance with the voltage of the ac supply, i.e. '230' for 198V to 252V or '115' for 90V to 126V, and that an ac supply fuse of the correct rating is fitted, i.e. 1.6A for '230' and 3.15A for '115'.

FAILURE TO SELECT THE CORRECT MAINS SELECTOR SETTING MAY RESULT IN DAMAGE TO THE INTERNAL POWER SUPPLIES.

In the interest of safety, it is essential that the RVC is connected to a protective ground via the earth lead.

4.1.2 Generator and Monitor Outputs

The generator has a floating differential output via two BNC sockets marked HI and LO in the GENERATOR section of the rear panel (see Fig 4.1).

A third BNC socket, marked MONITOR, provides a single ended, high impedance output suitable for an oscilloscope monitor.

A schematic diagram of the generator outputs is given in Fig 4.3.

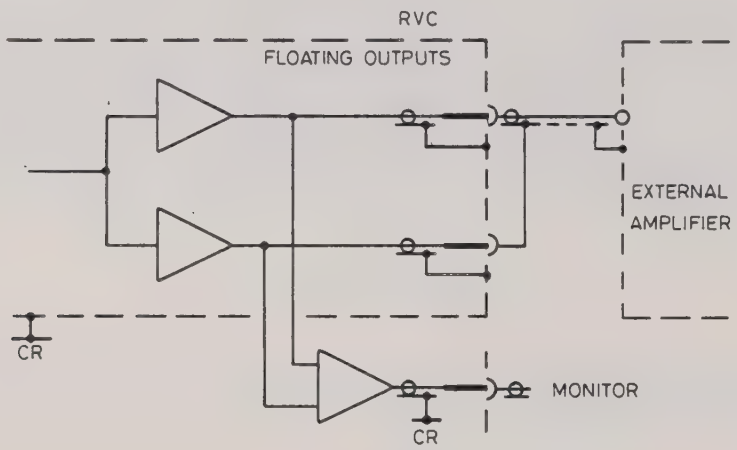


Fig. 4.3 *Generator outputs.*

Ideally the power amplifier to be driven by the generator should have differential inputs, but a reasonable compromise, for a single ended input, can be achieved by connecting it as shown in Fig 4.3. Alternatively, the Lo output of the generator can be grounded with a shorted BNC socket and the Hi output used to drive the amplifier.

Note that, for single ended input amplifiers, particular care is required with the system earthing, e.g. use star point earthing.

4.1.3 Signal Inputs

For each of the two types of input signal, connection is made on the INPUT section of the rear panel (see Fig 4.1). The connectors are marked CHARGE and VOLTAGE, and are selected via the front panel SET INPUT key (3.5.1).

The CHARGE input is a single microdot connector with a peak range of 10pC to 10nC. The VOLTAGE input configuration is differential, on two BNC sockets (marked HI and LO) with grounded outer connectors. The peak voltage range is 10mV to 10V.

Schematic diagrams of the charge and voltage input configurations are given in Figs 4.4 and 4.5 respectively.

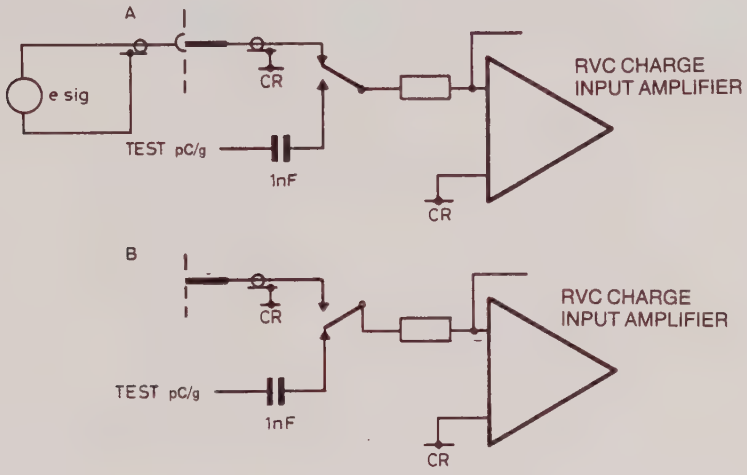


Fig. 4.4 *Charge input configurations: a) signal input; b) test input*

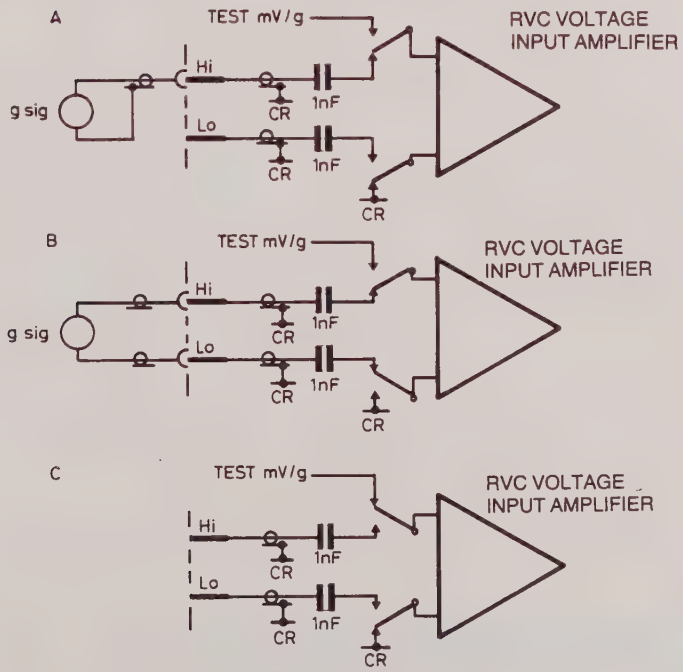


Fig. 4.5 *Voltage input configurations: a) single ended, b)differential, c) test*

4.1.4 Video

A composite video-synchronisation signal is output via the VIDEO BNC connector on the rear panel. The signal is a standard, non-interlaced 625 line 50Hz or 525 line 60Hz video signal with a peak level of 1V into 75Ω. An internal switch selects 50Hz or 60Hz frame rate.

4.1.5 Interlock

A 25 way 'D' type female connector allows the RVC to be connected to a test chamber interlock system.

The interlocked operation of the RVC with external equipment and the connections for this are described in Chapter 3, Section 3.12. The 'D' type connector pin functions are given in the following table:

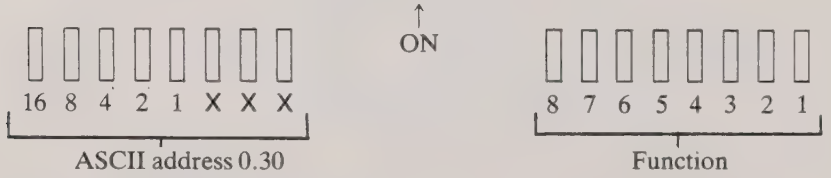
Pin	Function
1 ... 14	Relay contact closure output.
2	20mA current generator +ve
15	0V current generator −ve
3	20mA sensor +ve
16	20mA sensor −ve

(3 and 16: floating with respect to 0V)

4.1.6 GPIB

The GPIB connector carries the remote control input and output data. The connector and data format are in accordance with the IEEE 488-1978 standard.

The address and functions of the GPIB module are set up on the rear panel switches:



(Binary address = ASCII + 1)

1. Parallel Poll Bit 1
2. Parallel Poll Bit 2
3. Parallel Poll Bit 4
4. Parallel Poll Sense True (ON) ↑
5. Talk only
6. X
7. X
8. X

X = No function).

When used in conjunction with a digital plotter only the plotter should be switched to 'listen only' and the RVC to 'talk only'. The latter is accomplished by selecting the FUNCTION switch '5' to ON.

4.1.7 Analogue Plotter

An analogue plotter connects to the Plotter Interface via a 15-way Cannon connector. The connections are to be made in accordance with the following table:

Pin	Function	
1	ground (0V)	
2	X-channel output	
3	Y-channel output	
4	ground (0V)	
13	normally closed	Pen control contacts 14-15 pen down 14-13 pen up
14	common	
15	normally open	

4.2 ACCESSORIES

The RVC accessories are supplied in a plastic bag, which is contained in a tray at the top of the packing box. The accessory bag should contain:

★ rack mounting ears,

★ an ac supply lead,

★ fuses, 1.6A SLO BLO for a 230V ac supply and 3.15A SLO BLO for a 115V ac supply.*

★ fuses**, type 1 AT and 6.3 AT, for the internal dc power supplies of the RVC,

★ shorting BNC plug for generator Lo output

★ dummy 'interlock' plug, 25 way 'D' type.

**No attempt should be made to replace a fuse in an internal power supply without first consulting the Maintenance Manual.

When telescopic slides (Option 12001A) are ordered with the RVC, these, also, are contained in the packing box.

4.3 VENTILATION

The RVC has fan assisted ventilation. Air is drawn in beneath the projecting keyboard and exhausted at the rear of the unit, as shown in Fig 4.6.

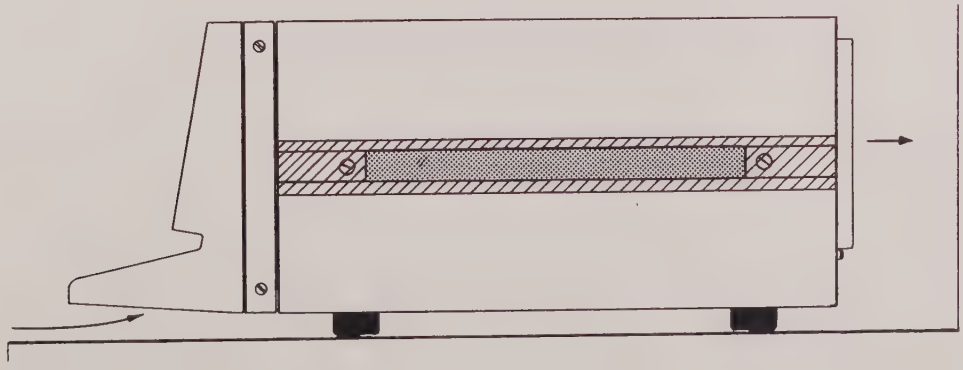


Fig. 4.6 *RVC ventilation air flow*

It should be ensured that the air inlet and outlet are always clear, otherwise overheating of the unit may occur. Bench mounted units should be positioned at least 100mm (4 ins) away from any vertical obstruction, such as a wall. With rack mounted units, the rack itself should be well ventilated.

4.4 RACK MOUNTING

To enable the RVC to be rack mounted, the accessory kit includes a pair of rack mounting ears. These should be fitted to the unit in place of the finisher trim (see Figs 4.8 and 4.9).

The RVC can be supported in the rack by fixed rails making contact with the underside of the case, the unit being held in place by screws inserted through the rack ears. It is much easier to withdraw the unit from the rack for servicing purposes, however, if it is supported in the rack with telescopic slides. These are available as Options 12001A and E. The internal rack dimensions required for fitting the unit are:

760mm (30 ins) deep by 485mm (19 ins) wide (panel fixing) for telescopic slide mounting and

610mm (24 ins) deep by 485mm (19 ins) wide for fixed rail mounting.

4.4.1 Mechanical Stability

When the RVC is rack mounted on telescopic slides it should be ensured that the rack will not tip over when the slides are fully extended. The distance of the center of gravity of the unit from the rack in this position is shown in Fig 4.7.

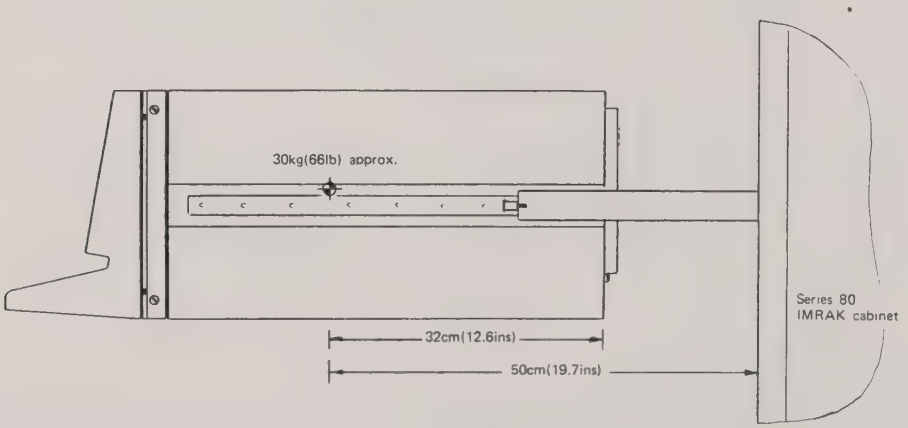


Fig. 4.7 *Position of the RVC on fully extended telescopic slides*

4.4.2 Ventilation

Adequate ventilation must be ensured for the rack in which an RVC is mounted, either by an
extractor fan or by having the back of the rack open.

4.4.3 Telescopic Slide Fitting Procedure (Option 12001A)

It is recommended that the following procedure is used when rack mounting the RVC with telescopic slides.

1. As demonstrated in Fig 4.8, remove the following items from the unit:

   ★ finisher trim, two off,
   ★ handle and handle trim, two off each,
   ★ feet, four off.

   Retain the finisher trim securing screws (M4 × 12 pan head) and M4 crinkle washers for securing the rack ears.

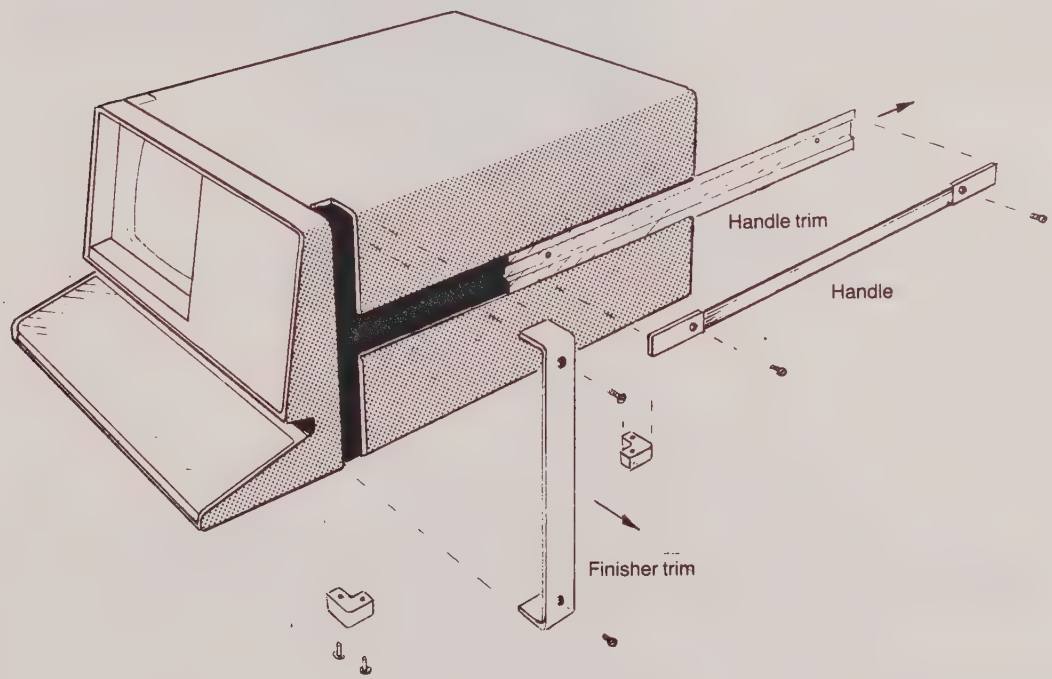


Fig. 4.8 *Removal of finisher trim, handle and feet*

2. As demonstrated in Fig 4.9, fit the following items to the RVC:

   ★ telescopic slide mounting bars, two off. These should be screwed to the chassis, using the M4 × 12 csk screws supplied. The broader of the two bars is fitted to the right hand side of the unit, looking from the front. Both bars should be fitted with the threaded holes nearest to the front.

   ★ telescopic slide inner members, two off,

   ★ rack ears, two off.

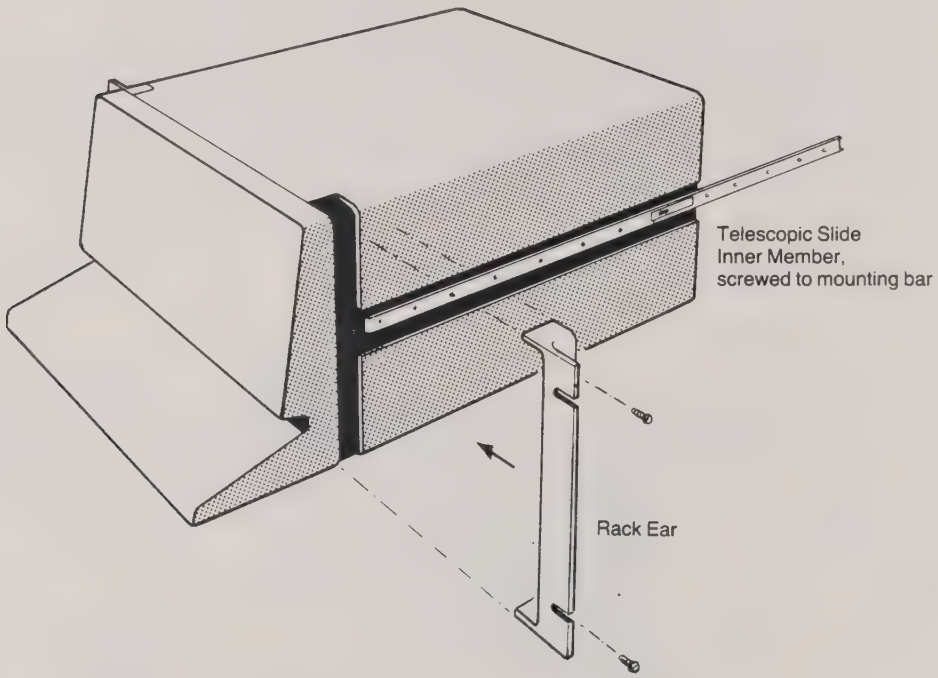


Fig. 4.9 *Fitting telescopic slide inner members and rack ears*

The telescopic slides are supplied with the inner and outer members slotted together. The inner member is removed in the direction indicated by the arrow in Fig 4.10. At the halfway point the locking catch should be depressed to release the member.

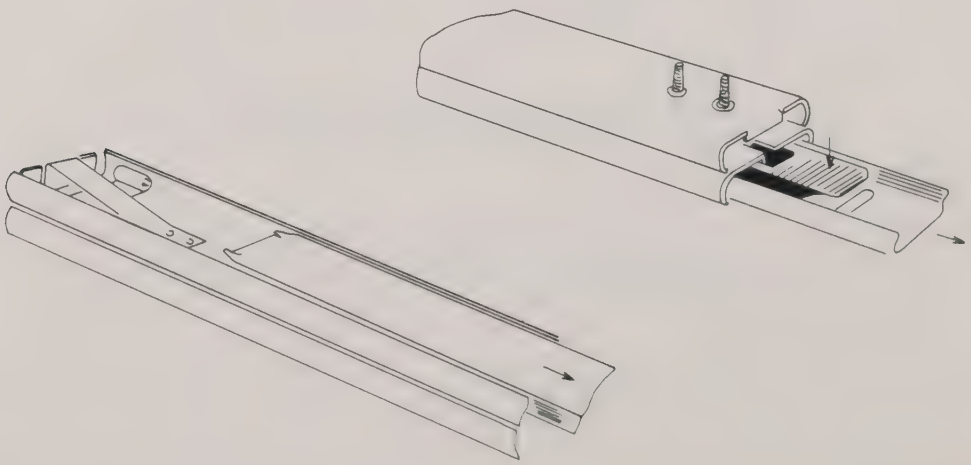


Fig.4.10 *Separating the inner telescopic slide from the outer, prior to fixing*

The telescopic slide inner members are screwed to the mounting bars fitted on either side of the RVC, using the 14 M4 × 8 pan head screws supplied.

The rack ears are fitted in place of the finisher trim, using the screws and washers with which the finisher trim was secured.

3. As shown in Figs 4.11 and 4.12, fit the following items to the telescopic slide outer members:

   ★ an adjustable rear bracket,

   ★ a fixed front bracket, together with a support bracket.

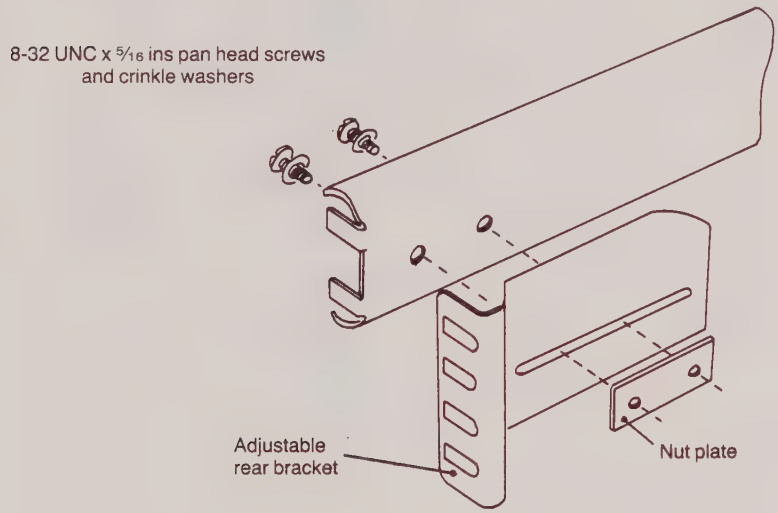


Fig. 4.11 *Fitting the rear bracket*

The screws on the adjustable rear bracket should not be fully tightened until the RVC is fitted into the rack (step 6).

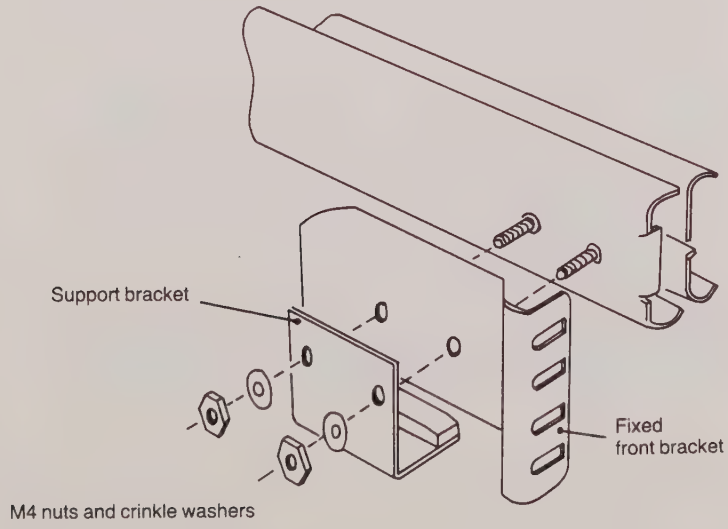


Fig 4.12 *Fitting the front bracket and the support bracket*

4. Fit the M6 caged nuts for outer slide member and rack ear fixing into the rack, in the positions shown in Fig 4.13. The way to insert, and to remove, caged nuts is demonstrated in the figure detail.

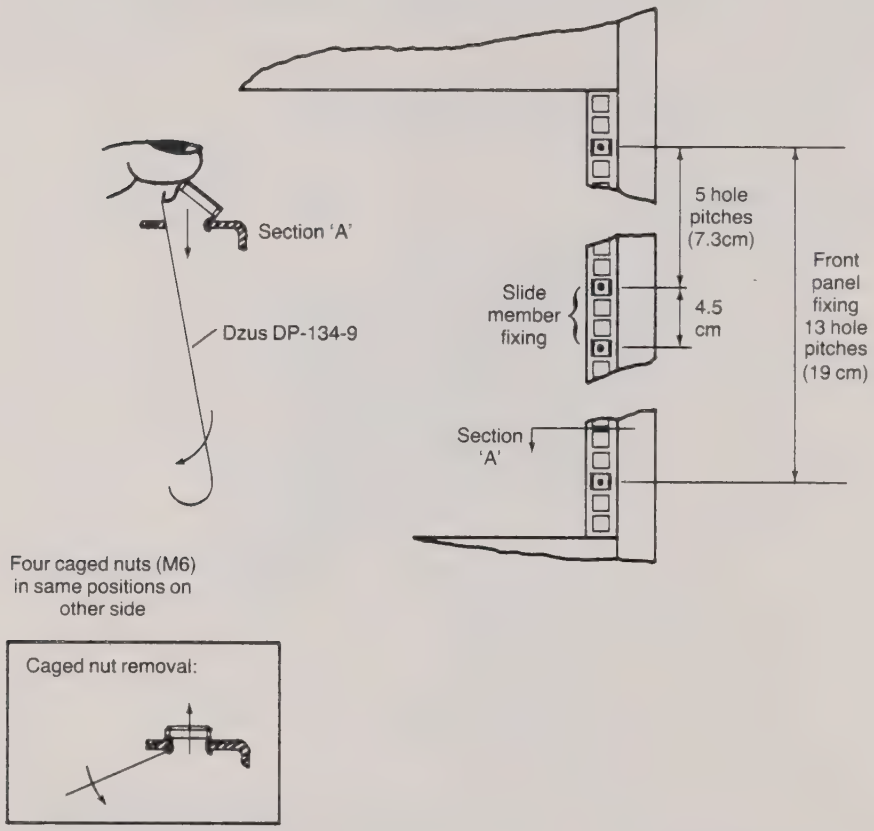

Section 'A'
Dzus DP-134-9
5 hole pitches (7.3cm)
Slide member fixing
4.5 cm
Front panel fixing 13 hole pitches (19 cm)
Section 'A'
Four caged nuts (M6) in same positions on other side
Caged nut removal:

Fig 4.13 *Cage nut insertion (and removal) in Imrack Series 80 (and similar) cabinets*

5. Fit the outer slide members to the rack as shown in Fig 4.4.14. Note that the tapped holes in the nut plate are placed off center to provide maximum lateral adjustment. The plates should be fitted, as shown, with the holes offset towards the outside of the rack.

   When fitting the first end of an outside member it is advantageous to support the member at the opposite end. This is done by hooking the bracket at the other end of the member over an M5 screw pushed into the top caged nut.

   For each outside member the M5 screws should be tightened until the member is held reasonably firmly in the rack, approximately in the center of its travel. The members must, however, be free to take up any adjustment when the RVC is first fitted into the rack.

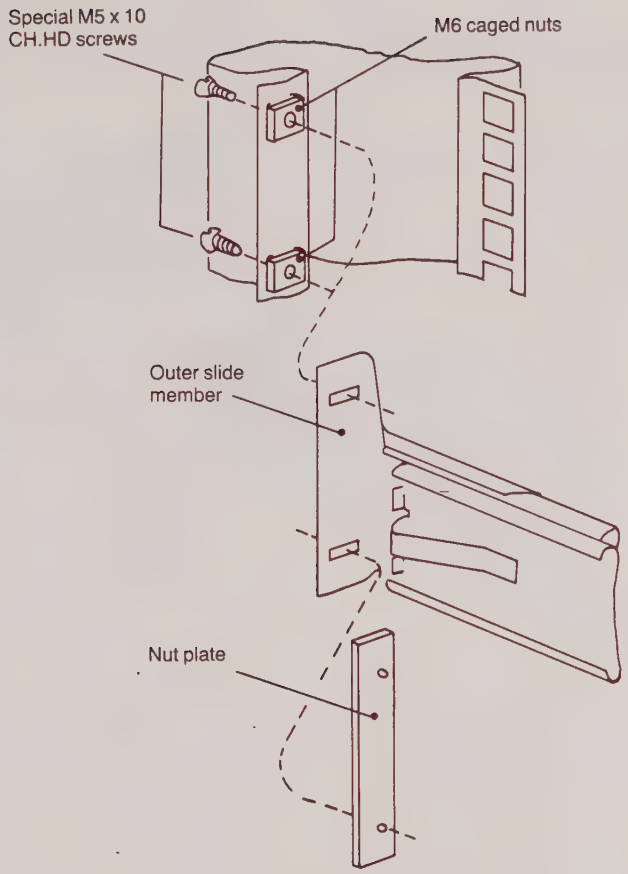


Fig 4.14 *Fitting the outer slide members into the rack*

6. Fit the RVC into the rack, proceeding as follows:

   ★ Introduce the inner telescopic slide members to the outer members, as shown in Fig 4.15.

   ★ Push the unit into the rack until the locking catches engage and lock.

   ★ Depress the release tabs shown in Fig 4.16, on both catches, and push the unit fully into the rack.

   ★ Ensure that the unit is properly positioned and that no cables are trapped, then tighten the screws on the outer slide member in the following order:

      1. The M5 screws securing the rear bracket to the rack.
      2. The M5 screws securing the front bracket to the rack.
      3. The 8-32 UNC screws securing the rear bracket to the outer slide member.

   ★ Ensure that the telescopic slides operate smoothly. If they do not, ease the screws tightened previously, adjust the slides, and retighten the screws.

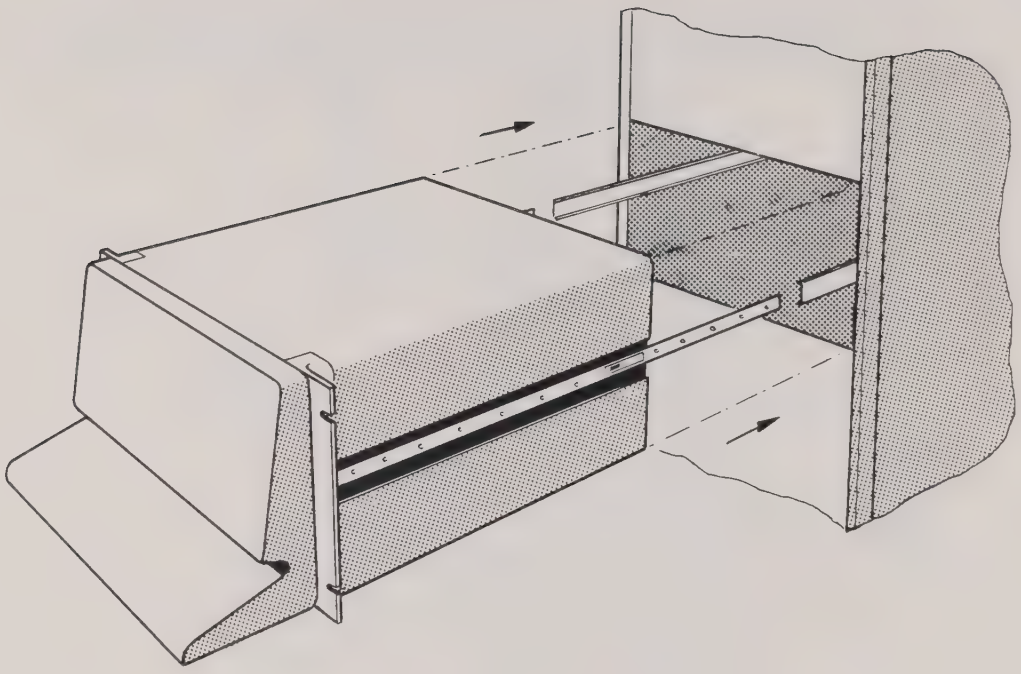


Fig. 4.15 *Introducing the telescopic slide iner members to the outer members*

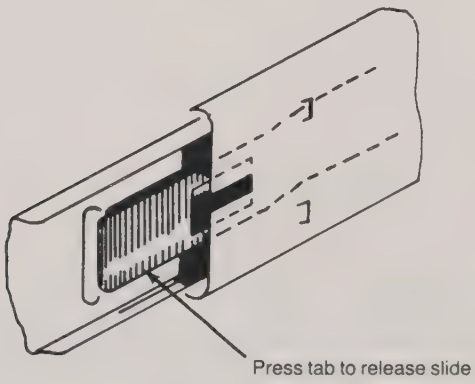


Fig 4.16 *Telescopic slide locking catch*

Chapter 5
External Control via the GPIB

CONTENTS

		Page
5.1	Introduction	5.1
5.2	Command Overview	5.2
5.3	Setting the Keyboard	5.3
5.4	Reading the Keyboard	5.4
5.5	Controlling the Tests	5.5
5.6	Accessing the Data Buffers	5.6
5.7	GPIB Interface Facilities	5.8
5.8	GPIB Commands	5.10
5.9	Index of GPIB Commands	5.19
5.10	Application Examples	5.20
5.11	Command Syntax	5.27

CHAPTER 5 EXTERNAL CONTROL VIA THE GPIB

5.1 INTRODUCTION

External control is achieved via the GPIB interface, which is designed in accordance with the IEEE488-1978 standard.

The command language is based on the front panel operations. Each command consists of a simple string of ASCII alpha-numeric characters whose significance parallels that of the hard key-soft key arrangement. The numeric parts of a command may be in fixed point or exponential form; either is recognised by the RVC without prior definition. This simple command structure ensures that the control program is extremely easy to write and to debug.

The GPIB commands comprise those which duplicate the function of the front panel controls, plus an additional suite. Together, these commands provide the following facilities:

- ★ setting the keyboard
- ★ reading the keyboard
- ★ controlling the tests
- ★ accessing the data buffers

Two GPIB ports are used, one for ASCII commands and data and the other for binary data. This eliminates many of the problems associated with the mixing of ASCII and binary information.

The use of direct memory access (DMA) techniques has resulted in a data transfer rate of 250 kbytes/sec (max).

5.2 COMMAND OVERVIEW

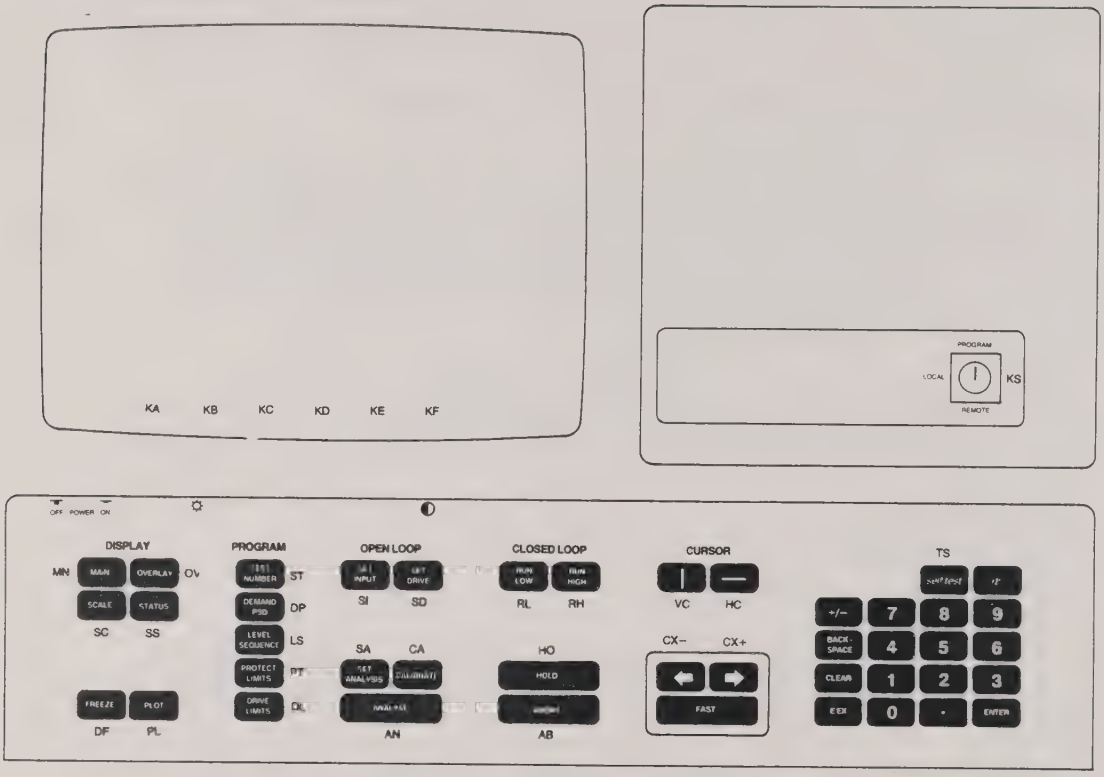


Fig. 5.1 *Equivalent GPIB command codes*

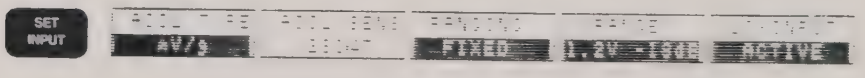
5.2.1 GPIB Commands

All commands to the RVC are sent to the ASCII listen device address. Single or multiple commands may be sent in one line (or message) and execution begins when a line terminator (line feed) is encountered. New commands sent while ASCII output or binary data input/output is in progress will override previous requests and abort pending input/output.

5.2.2 GPIB Command Format

Each command consists of a command code (two alpha characters) followed by up to seven numeric arguments.

Every front panel key has a corresponding command code (see Fig 5.1). Similarly, each of the menu keys selected by a front panel key has a corresponding argument. The relationship between the position of a menu key on the front panel and the position of the corresponding argument in a GPIB command is shown in Fig 5.2.



SI, 1, 281.47, 2, 8, 1

Fig. 5.2 *Menu key-command argument relationship*

Details of the commands and parameters available are given in Section 5.8.

5.2.3 Output Data Format

In a sequence of numbers each number is terminated with the characters defined by the 'OF' (Output Format) command.

OF1; This is the default state. A comma (,) is used to terminate each number; except the last, which is followed by <carriage return><line feed>.
OF2; All numbers are terminated with <carriage return><line feed>.
OF3; All numbers are terminated with <carriage return>.

A typical example of the use of the output format command is:

```
OUTPUT 700; "OF2"
```

which terminates all numbers with carriage return, line feed.

5.3 SETTING THE KEYBOARD

For each manual command there is an equivalent GPIB command and, for these commands, external operation of the RVC exactly parallels local operation. To be able to set the controls, therefore, the user should be familiar with the procedure outlined in Chapter 2. The format of the GPIB commands is defined in Section 5.2, whilst details of each command available are given in Section 5.8. Examples of application programs using the GPIB commands are given throughout this chapter. Four typical uses of GPIB commands are:

a)
```
20 PRINT "TYPE ACCL SENSE";      !Prompt message for operator.
30 INPUT A                       !Operator enters variable 'A'.
40 OUTPUT 700; "SI, 1,"; A; ",2,8"   !SET INPUT menu set.
```

This simple routine allows an operator to enter the accelerometer sensitivity, and sets the SET INPUT menu.

b)
```
10 OUTPUT 700; "KS3"
```

This command sets the keyswitch to REMOTE and allows the selected test to begin on receipt of a remote DRIVE REQUEST signal. Note that argument '3' follows the command 'KS' without a comma; this is always the case for external only commands (i.e. commands without keyboard equivalents).

c)
```
10 OUTPUT 700; "SA, KB1, KD"
```

This command sets the average decay to one second (second menu key) and executes the average reset (fourth menu key). Menu keys are specified by the identifiers KA-KF, where KA is the first menu key from the left.

d) The entire keyboard setting for a particular test may be loaded in binary to the RVC. A test may thus be defined very quickly. The following HP85 program example shows how the test settings may be read from a file on tape and written to the RVC.

```
 10 ! TEST PROGRAM FOR "TI" COMMAND
 20 ! GETS DATA FROM FILE "binary"
 40 DIM Z$[2100]
 50 IO BUFFER Z$
 60 ASSIGN# 1 TO "binary"
 80 READ# 1; Z$
 85 OUTPUT 700; "TI"
 90 TRANSFER Z$ TO 701 FHS
100 ASSIGN# 1 TO *
120 END
```

5.4 READING THE KEYBOARD

The settings of a particular menu may be read simply by writing the menu code and a query (?) to the RVC. Details of specific menu queries are given in Section 5.8. Three typical examples of a menu query are:

a)
```
 10 DIM A$[100]
 20 OUTPUT 700; "TM?"
 30 ENTER 700; A$
 40 PRINT A$
```

This simple routine produces information on the state of a particular test, e.g.

6, 4, 2, 120, 0, 5, 33 <cr lf>

This example shows that the RVC is operating in RUN HIGH (6) on test 4, level 2, that the elapsed time on level 2 is 120 seconds, and that the elapsed time from the beginning of the test is 0 hours, 5 minutes and 33 seconds.

Note that the command on line 20 is an external only command and therefore the seven arguments produced are all valid. Seven arguments are produced for all output commands, but the value of the first one for keyboard equivalent commands is normally zero.

b)
```
 10 OUTPUT 700; "TS,3"          !Select correct menu and update clock.
 20 OUTPUT 700; "TS?"           !Request time.
 30 ENTER 700; A, B, C, D, E
 40 PRINT "HOURS="; C
 50 PRINT "MINS="; D
 60 PRINT "SECS="; E
```

The above program for reading the time contains an example of a command query, "TS,3" on line 20, which requires the arguments, specified on line 30, to be correctly updated prior to command execution. Note that argument 'A' is a dummy output (= 0) in this command and 'B' is the menu selection (3). The sixth and seventh output arguments are ignored, and are discarded by the RVC when the next command is sent.

Another example of a query command which requires the arguments to be specified prior to execution is the CI? command, which is used for reading cursor intercept values.

c) The entire RVC test setting may be read and stored in binary for later use. The following HP85 program example, which complements example 5.3d above, illustrates the method.

```
 10 ! TEST PROGRAM FOR "TO" COMMAND
 20 ! SAVES DATA IN FILE "binary"
 30 DIM Z$[2100]
 40 IO BUFFER Z$
 45 ASSIGN# 1 TO "binary"
 50 OUTPUT 700; "TO"                    !Command RVC to output settings.
 60 TRANSFER 701 TO Z$ FHS, COUNT 1024
 90 PRINT# 1; Z$                        !Transfer binary setting from RVC to Z$
160 ASSIGN# 1 TO *
200 END                                 !Store on tape.
```

5.5 CONTROLLING THE TESTS

The GPIB controller may control the tests by writing the appropriate command to the RVC, e.g.

OUTPUT 700; "AN" starts an analysis
OUTPUT 700; "RL" starts a RUN LOW operation
OUTPUT 700; "AB" sets the RVC to ABORT.

To enable the controller to follow the progress of a commanded operation the RVC may be programmed to interrupt the controller when a specific event has occurred. This feature uses the SV command, which enables a function (or functions) to set the rsv bit in the STB status byte of the GPIB interface. The STB status byte may be accessed via the serial poll sequence, as defined in the IEEE 488 specification.

The format of the STB byte is as follows:

bit 8 . rqs bit 1 msb 1sb

The 'rqs' (request service) bit, when set to 'l', indicates that an interrupt has been generated by the interface.

An interrupt may be generated on entry to any one of the machine states, as defined by the SV command.

SV Function;

STB bit	Command	Function
1	SV1	abort
2	SV2	analyse
3	SV4	run low
4	SV8	run high
5	SV16	level sequence complete
6	SV32	plot complete
7		request service
8	SV128	display update complete

Several commands can be combined by adding the numerical parts together, e.g. SV3, abort and analyse.

Note that, because of multiple buffering within the RVC, the SV command should be followed by at least 3 message terminators (i.e. CR, LF) to ensure that it correctly executes before reading STB.

When an interrupt is enabled and 'rqs' is set, the configured parallel poll bit will be asserted during a GPIB parallel poll operation. To clear 'rqs' and the parallel poll bit repeat the required SV command or send SV-1.

The use of the SV command is illustrated in the following program:

```
10  OUTPUT 700; "KS1"                  !Select PROGRAM status.
20  OUTPUT 700; "TS,1"                 !Select TEST # 1.
30  OUTPUT 700; "SV17"                 !Set rqs on level sequence complete or abort.
40  OUTPUT 700; "RH"                   !Start RUN HIGH.
50  OUTPUT 700;                        !3rd SV terminator.
60  S = SPOLL (700)                    !Request serial poll.
70  IF BINAND (S, 64) = 0 THEN 60      !Check rqs with binary AND function.
80  IF BINAND (S, 16) = 1 THEN 200     !Check level sequence complete.
90  IF BINAND (S, 1)  = 1 THEN 300     !Check abort.
100 STOP

200 PRINT "TEST COMPLETE"
210 STOP

300 PRINT "TEST ABORTED BEFORE END"
310 STOP
```

Note that 'RVC abort' occurs immediately after 'level sequence complete'. Therefore it is necessary to check 'level sequence complete' first; this avoids confusion with any abort that may be caused by an error condition.

5.6 ACCESSING THE DATA BUFFERS

The GPIB controller may access four data buffers within the RVC. These are:

1. **Demand Profile (DM) Buffer** [Read/Write]
   The demand profile of the present test may be read from the DM buffer, or a new profile for the same test may be written into it.

2. **Last Drive (DR) Buffer** [Read/Write]
   The profile of the signal last used to drive the system under test may be read from the DR buffer, or a new profile for the present test may be written into it.

3. **Main Function (MF) Buffer** [Read Only]
   The main function presently displayed may be read from the MF buffer. The required function should be selected prior to execution of the MF command, e.g. 'MN3' selects the average psd.

4. **User Display (UD) Buffer** [Write Only]
   The UD buffer will accept data for display from the controller. This data may be either a previously saved display function (obtained via the MF buffer) or the users own data. The UD command should be followed by an MN19 main display command, which displays the input data. Overlay may be used to compare previous and present results, alarm limits, etc. Data input to the UD buffer is assumed to be psd data in g^2/Hz units. Scaling as set by the scale command is applied.

5.6.1 Buffer Command Format

The general form of the commands used to gain access to the data buffers is as follows:

XX data type, I/O

XX	DM	demand profile buffer
	DR	last drive buffer
	MF	main (display) function buffer
	UD	user display buffer
data type	1	ASCII
	2	binary
I/O	1	input to RVC
	2	output from RVC

An example of a typical buffer command is:

OUTPUT 700; "DM1,2"

which sets the demand profile buffer to be read in ASCII.

Note that the I/O type should be '2' (output) for the MF buffer and '1' (input) for the UD buffer, otherwise a 'number out of bounds' error will occur.

5.6.2 Binary Data Transfers

For all the data buffers described above the data may be either in binary or in ASCII form. The format of the binary data, described in Section 5.6.3, should be borne in mind if the user needs to convert the data to comply with the internal format of his controller. For applications which are not time critical it may be advantageous to use the ASCII input/output facility; this will relieve the user of the conversion problem. ASCII data transfers are described in Section 5.6.4.

5.6.3 Binary Data Formats

A block of binary data acceptable to an RVC buffer consists of a 16-bit block exponent followed by 501 32-bit data words. Data should be sent with the most significant byte first and each transfer should contain an even number of bytes.

5.6.3.1 Exponent Format

The exponent format is as follows:

msb lsb byte 1 byte 2

16 bits represent the 2s exponent of each data element in the buffer section, i.e. they constitute the block exponent. The value of this is expressed in excess 16k format i.e.

a value 16383_{10} $(=3FFF_{16})$ = an exponent of -1
a value 16384_{10} $(=4000_{16})$ = an exponent of 0
a value 16385_{10} $(=4001_{16})$ = an exponent of 1

etc.

The range of values is 0 (representing exactly zero data) to $+ 32767_{10}$ $(7FFF_{16})$, which gives a 2s exponent range of -16384 to $+16383$. However, the normal data that should be expected produces an exponent in the range $\pm$ 330 (i.e. equivalent to $10^{\pm 99}$).

5.6.3.2 Data Format

byte1 byte 2 exponent

msb byte 3 byte 4 byte 5 byte 6 lsb data etc.

When the 32 bit data word is recombined in the form shown above it represents a fractional 2s complement number. The radix point is considered to be at the right of the sign bit.

The number is not normalized and its absolute value is found by multiplying by 2 raised to the power of the exponent.

A total of 501 data always follow the exponent, making a total of 2006 bytes.

For the above formats the binary data immediately follow the relevant GPIB command 'message delimiter'. It is assumed that the character following the message delimiter is the first byte of the exponent. All binary data should be transferred via the binary talk/listen address of the GPIB interface. This address is always one greater than the ASCII talk/listen address. To abort binary transfer, simply send a new GPIB command to the ASCII listen address.

5.6.4 ASCII Data transfers

The ASCII input/output facility relieves the user of the task of formatting the binary data. All data is transferred in the standard numeric format, as described in Section 5.11.2. The exponent is included in the data, i.e. absolute data values are transferred.

A block of ASCII data acceptable to an RVC buffer consists of 501 32-bit real numbers. For ASCII data written into a buffer the RVC generates a block exponent to which the 501 real numbers are normalised. To allow this to be done correctly the user must specify the maximum value to be input. The maximum value must precede the 501 real numbers and the suggested method of specifying it is to include it in the buffer command, e.g.

OUTPUT 700; "DM1, 1, 100"

which specifies an ASCII input to the RVC with a maximum data value of 100.

To avoid an overflow when writing into a buffer it is necessary to terminate each ASCII input number with a message terminator, e.g. CR, LF.

All ASCII transfers take place using the ASCII talk/listen address on the GPIB interface.

As with other data transfers, sending another ASCII command will abort the transfer.

5.7 INTERFACE FACILITIES

5.7.1 GPIB Local-remote

In the GPIB interface, the complete IEEE 488 local-remote control logic has been implemented. The 'return to local' (rtl) message is generated by the rtl key on the front panel.

All data transfers to and from the RVC are made with the interface in the 'remote' state; in 'local', all GPIB commands are ignored.

A change from 'remote' to 'local' during ASCII or binary input or output data transfers results in the remaining data being discarded.

Note that the LOCAL and REMOTE settings of the front panel key switch do not relate to local or remote operation of the RVC through the GPIB interface, but to the functions described in Sections 1.3 and 3.11. To avoid confusion, therefore, the equivalent terms 'manual' and 'external' are used in the remainder of the operating manual when referring to local and remote control, respectively, as defined above for the GPIB.

5.7.2 Interface Addresses

The GPIB interface has two addresses, one for ASCII input-output and the other for binary input-output. The address of the ASCII input-output port is defined by a rear panel switch (see Fig 5.3). The address immediately following this will select the binary input-output port. Only one of these ports may be active at any one time. Accessing the ASCII listen address will overwrite all other input-output states and will abort any pending input-output data.

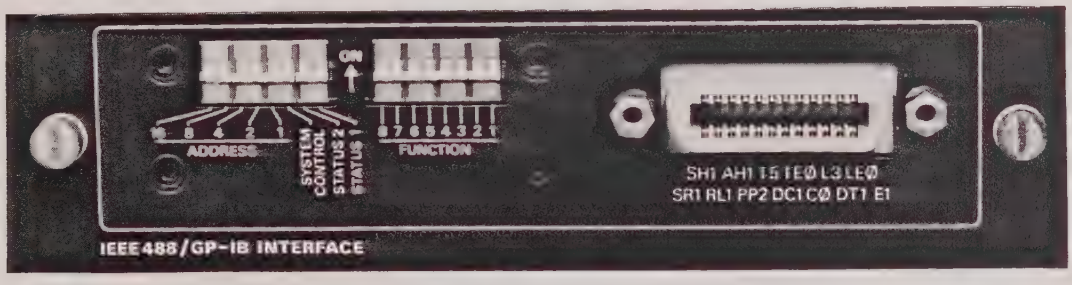


Fig. 5.3 *Rear panel GPIB switches*

5.7.3 Parallel Poll Configure

Switches 3, 2 and 1 on the FUNCTION switch (see Fig. 5.3) enable the user to specify the parallel poll configure bit (1-8) for PP2 implementation. Switch 4 allows the poll sense to be selected (ON = True).

5.7.4 End or Identify (EOI)

EOI may be used as an GPIB command terminator only. It has no effect during binary transfers and is not available as an output data terminator.

5.7.5 Controller Capability

No GPIB controller facility is available. Hence the 'system control' switch on the rear panel should be set to 'OFF'.

5.7.6 Talk Only

A 'talk only' function is available for use with the digital plotter output and is enabled by FUNCTION switch 5. When 'talk only' is enabled (FUNCTION switch 5 set to 'ON') the plotter output can be controlled directly from the front panel.

It is, however, necessary for the plotter to have a 'listen only' facility to enable it to accept the data from the RVC.

If 'talk only' is enabled it is still possible to connect a GPIB controller to the RVC. Sending the message DCL (Device Clear) to the GPIB interface will cause 'talk only' to be disabled and normal communications to be resumed until either the RVC is initialised (IN command) or the power up sequence is executed.

No 'listen only' facility is available on the RVC GPIB interface.

5.7.7 GPIB Connector

The socket on the rear of the GPIB interface mates with a standard IEEE 488 connector, i.e. a 24 pin Amphenol connector with 'jack post' mounting.

5.8 GPIB COMMANDS

ABORT

AB

ANALYSE

AN

CALIBRATE

CA, 1, frequency, g peak, wedge (mm), wedge (in)

frequency	6 – 3000 Hz
g peak	0 – 1 E + 18
wedge (mm)	0.1 – 100
wedge (in)	0.003937 → 3.937

CA, 2, V peak, V incr, level up, level down

V peak	0 → 10
V incr	0 → 10

Cursor Intercept Data

CI frequency; CI?

frequency	6 – 3000 Hz

This command results in the output of the following data

frequency, actual frequency, cursor intercept, data cursor intercept

★ frequency and actual frequency will differ only if the frequency specified in the command is not a multiple of 6Hz.

Cursor Move

CXn

n ± 502

Data Buffer Access

It is possible to access data in the following buffers:

1.	Demand profile	command	DM
2.	Last drive profile	command	DR
3.	Main (display) function	command	MF
4.	User display function	command	UD

The general format for transfers through these buffers is as follows:

XX data type, I/O

data type	1 ASCII 2 binary
I/O	1 input to RVC 2 output from RVC

The following points should be considered before attempting buffer transfers.

1. DM and DR

Transfers may take place in either direction, and the data may be in ASCII or binary form.
Note that the total grms values for these buffers are available using the SG? command. Note also that suitable values on input should be set using SGn,m.

2. MF

This command is available as an output only. Therefore the I/O type should always be specified as 2, otherwise a number of out of bounds error will occur.

Since the MF command outputs a copy of the currently selected main function buffer, the required function, e.g. 'MN3', which selects average psd, should be selected prior to execution.

3. UD

This command enables users to enter their own (or previously saved) profile for display. Again, data may be in ASCII or binary but, since input only is available, the I/O parameter in the command should be set at 1.

Execution of the UD command should be followed by an MN19 command, which displays the input data. Overlay may be used with this display to compare previous and current results, alarm limits Scaling as set by the scale command is used.

4. Data Buffers – General

The acceptable format for binary input/output data is a 16-bit exponent followed by 501 32-bit data words.

The acceptable format for ASCII input/output data is 501 32-bit real numbers; a block exponent, to which all the data are normalised is generated automatically by the RVC. To ensure a successful data transfer the maximum value to be input should precede the 501 real data; the suggested method is to include it in the buffer command, e.g.

OUTPUT 700, "DM1,1,100"

This sets the block exponent in the RVC buffer, ensuring that all entries are within range.

Word size

The basic word size used in the RVC is 16 bits. This means that for a 501 pt binary buffer transfer, plus block exponent, 2006 bytes are accessed, and the user's file sizes should be set accordingly.

DEMAND PSD

DP, Step, frequency amplitude, slope, abort dB

step	> step to next breakpoint (higher frequency) < step back to previous breakpoint (lower frequency)
frequency	0-3000 Hz
amplitude	1E-6, 100
slope	−11000, +11000 dB/Oct
abort dB	0.1 – 20

★ BP may be used instead of DP if fast entry of breakpoints is required, since using BP does not recalculate a new demand profile on each entry. When entry of a profile using BP is complete a new demand PSD may be recalculated either by using DP for the final breakpoint entry or by reselecting the test number using the ST command.

DRIVE LIMITS

DL, run low %, crest factor, run up(s), run down(s), safe V(pk)

run low %	0.1–100
crest factor	1.4–8
run up(s)	1 – 100
run down(s)	1 –100
safe V (pk)	0 – 10

Error Status

RE?

Error numbers are returned in the following order:

last error, previous error, last abort, last warning, low limit, high limit

Warning messages	101	Drive limit at safe V peak
	102	Slope out of range
	103	Test cleared
	104	All tests cleared
	105	Alarm, PSD outside limits

Error messages	200	Input overloaded
	201	Common mode/HF overload
	202	(not used)
	203	Set amplitude
	204	No free breakpoints
	205	10 levels specified
	206	Select abort
	207	Value fixed
	208	Plot limits incompatible
	209	No interlock request
	210	Not active in local
	211	Not active in remote
	212	System test failure
	213	Interface test failure
	214	Number out of bounds
	215	Numeric entry ignored
	216	Local locked out
	217	Not active in 'ext' mode
Abort messages	301	Open loop
	302	Drive out of bounds
	303	PSD outside limits
	304	grms limit exceeded
	305	Level sequence complete
	306	Terminated externally
	307	grms not defined

FREEZE

DF1 freeze OFF, DF2 freeze ON

HOLD

HO

Horizontal Cursor

HC, graticule

graticule	1	OFF
	2	ON

Input to Test Store (Computer to RVC)

TI

This command performs the reverse of TO

N.B. The data content or format (of the 2048 bytes) should not be modified between TO and TI commands, and should simply be saved in a suitably dimensioned file.

Keyswitch and Interlock

KS1	PRGM
KS2	LOC
KS3	REM

KS?

This query command returns the following information regarding keyswitch and interlock status.

keyswitch, interlock bit

keyswitch	0 PRGM 1 LOC 2 REM
interlock (bit)	1 ready o/p) active high 2 request i/p)

These are active in EXT only and override the front panel switch.

LEVEL SEQUENCE

LS, step, level #, grms, period, abort %

step	> step to next level < step back to previous level
level #	0–99
grms	0 – 1E + 18
period	0 – 32000
abort %	100 – 1000

Loop Status

LP?

This command reads the loop internal parameters in the following order:

test grms, abort count, alarm count, i/p peak, i/p grms, drive grms

MAIN

MNn

1	Select test, test signal
2	Select test, instant psd
3	Select test, average psd
4	Select demand, demand psd
5	Select demand, loop error
6	Select demand, transfer function
7	
8	
9	Select drive, drive signal
10	Select drive, drive psd
11	Alarm limit upper absolute
12	Abort limit upper absolute
13	Alarm limit lower absolute
14	Abort limit lower absolute
15	Alarm upper ratio
16	Abort upper ratio
17	Alarm lower ratio
18	Abort lower ratio
19	Display User Data (UD) buffer

Output Test Store (RVC to Computer)

TO

The TO command starts a binary transfer to 2048 bytes from a non-volatile store within the RVC. This store holds the control data for eight complete tests, as set by the keyboard commands.

OVERLAY

OV,1, limits

limits	1	overlay off
	2	alarm limits
	3	abort limits

OV,2, psd function

function	1	instant psd
	2	average psd
	3	demand psd
	4	drive psd

Compatible overlay functions may also be set using the same format and numbers (1 to 10) as MAIN, and substituting OV for MN. The following overlay functions are also available:

OV0	overlay off
OV7	alarm limits
OV8	abort limits

Plot

PL, 1, plot stop, plot start, plot zero, plot full scale

PL, 2, plotter type, annotation, size, speed

plotter type	1	analog
	2	GPIB
annotation	1	on
	2	off
size	1	A3
	2	A4
speed	1	fast
	2	medium
	3	slow

PL, 3, select, value, increment, increase, decrease

select	1	fixed
	2	Xmin
	3	Xmax
	4	Ymin
	5	Ymax
value	0→	16720
increment	0→	16720

Poll Mask

SV function(s);

STB bit	Command	Function
1	SV1	abort
2	SV2	analyse
3	SV4	run low
4	SV8	run high
5	SV16	level sequence complete
6	SV32	plot complete
7		request service
8	SV128	display update complete

This command enables a function, or any one of a group of functions, to set the request service (rsv) bit, bit 7, in the STB status byte of the GPIB interface. SV1, for example, will set the rsv bit for ABORT, whilst SV3 (bits 1 and 2 of the STB byte both set to '1') will set the rsv bit for either ABORT or ANALYSE. The STB byte may be accessed via the serial poll sequence, as defined in the IEEE 488 specifications.

Note that, because of multiple buffering within the RVC, the SV command should be followed by at least 3 message terminators (i.e. CR, LF) to ensure that it correctly executes before reading the STB.

PROTECT LIMITS

PT, abort %, abort count

abort %	1–100
abort count	1–501

RUN HIGH

RH

RUN LOW

RL

SCALE

SC, 1, freq range, data units, log ref, offset %

freq range	1 Lin 0–3K 2 Log 3–30 3 Log 3–300 4 Log 3–3K 5 Log30–300 6 Log 30–3K 7 Log 300–3K
data units	1 g^2/Hz 2 g/$\sqrt{}$ Hz 3 log
log ref	1E–18 → 1E+18
offset %	± 100

SC,2, mode, data min, range

mode	1 auto 2 fixed
data min	–1E–18 → 1E+18
range	0 → 2.147 E+09

Self Test

TS, 1, power up test, system check,, system init
TS, 2, clear all tests, clear test #

clear test # 1–8

TS, 3, set hours, mins, seconds

Self Test Query

TQ?

This is a query request only and returns information about the current self test or power up status. It can be used during the self test sequence to access status information at 'halt on error' points, and will cause error data to be output and continue to the next test.

Outputs are: test number, error status, error at address, data expected, data read.

SET ANALYSIS

SA, channel resolution, test decay, average mask, average reset

channel resolution	1 6Hz 2 12Hz 3 24Hz
test decay	0.1 → 100 s
average mask	1 0–3kHz 2 as demand profile

SET DRIVE

SD, drive grms, drive g/V, profile

drive grms	0 → 1E+18
drive g/v	1E–18 → 1E+18
profile	1 flat profile 2 demand profile 3 drive profile

SET INPUT

SI, accel type, accel sensitivity, ranging, range

accel type	1 mV/g 2 pC/g
accel sensitivity	1E–18 to 1E+18
ranging	1 auto 2 fixed

range	1	10mV
	2	20mV
	3	40mV
	4	80mV
	5	0.16mV
	6	0.31V
	7	0.62V
	8	1.2V
	9	2.5V
	10	5V
	11	10V

Sigma grms

SG demand, drive buffer

This command enables the drive and demand sigma grms values to be set. These values may be output from the RVC using the SG? command.

STATUS

SS,n

n= 1	off
2	GPIB status
3	test definition
4	error status
5	system status

Test Mode and Status

TM?

This command returns the following data.

Loop mode, test #, level #, level seconds, elapsed hrs, elapsed mins, elapsed secs.

Loop mode	0	abort
	1	hold analyse
	2	hold run low
	3	hold run high
	4	analyse
	5	run low
	6	run high
	7	calibrate

TEST NUMBER

ST, test #, edit mode

test #	1–8	
edit mode	1	menu
	2	table

Vertical Cursor

VC, graticule	graticule	1	OFF
		2	ON

5.9 INDEX OF GPIB COMMANDS

		Page
AB	Abort	5.10
AN	Analyse	5.10
CA, 1, frequency, g peak, wedge (mm), wedge (in)	Calibrate drive	5.10
CA, 2, V peak, V incr, level up, level down	Calibrate level	5.10
CI frequency; CI?	Cursor intercept output	5.10
CXn,	Cursor move	5.11
DF1	Freeze OFF	5.13
DF2	Freeze ON	5.13
DL, run low %, crest factor, run up(s), run down(s), safe V(pk)	Drive limits	5.12
DM	Demand profile buffer	5.11
DP, Step, frequency, amplitude, slope, abort dB	Demand psd	5.12
DR	Last drive profile buffer	5.11
HC, graticule	Horizontal cursor	5.13
HO	Hold	5.13
KS1	Keyswitch to PROGRAM	5.13
KS2	Keyswitch to LOCAL	5.13
KS3	Keyswitch to REMOTE	5.13
KS?	Keyswitch and interlock status	5.14
LP?	Loop status	5.14
LS, step, level #, grms, period, abort %	Level sequence	5.14
MF	Main (display) function buffer	5.11
MNn	Main (display) function	5.14
0V,1, limits	Overlay limits	5.15
0V,2, psd function	Overlay psd function	5.15
PL,1, plot stop, plot start, plot zero, plot full scale	Plotter control	5.15
PL,2, plotter type, annotation, size, speed	Plotter format	5.15
PL,3, select, value, increment, increase, decrease	Plotter scaling	5.15
PT, abort %, abort count	Protect limits	5.16
RE?	Error status	5.12
RH	Run high	5.16
RL	Run low	5.16
SA, channel resolution, test decay, average mask, average reset	Set analysis	5.17
SC, 1, freq, range, data units, log ref, offset %	Scale units	5.16
SC, 2, mode, data min, range	Scale mode	5.17
SD, drive grms, drive g/V, profile	Set drive	5.17
SG demand, drive buffer	Sigma grms	5.18
SI, accel type, accel sens, ranging, range, Lo input	Set input	5.17
SS,n	Status page	5.18
ST, test #, edit mode	Test number	5.18
SV function(s)	Poll mask	5.16
TI	Input to test store	5.13
TM?	Test mode and status	5.18
TO	Output test store	5.15
TQ?	Self test query	5.17
TS, 1, power up test, system check, system init	RVC tests	5.17
TS, 2, clear all tests, clear test #	Clear test(s)	5.17
TS, 3, set hours, mins, seconds	Set time	5.17
UD	User display function buffer	5.11
VC, graticule	Vertical cursor	5.18

5.10 APPLICATION EXAMPLES

This section contains typical examples of RVC application programs written for the HP85 and HP9835 computers. The aim of these examples is to give a realistic demonstration of the data formats and commands encountered in externally controlled RVC operation, and, as such, they are generally adaptable to other command languages.

5.10.1 Save, Clear, and Load Test Store

The following program, TSTSAV, saves the contents of the test store in a data file on tape cassette and clears the contents of the RVC test store. The RVC then displays the test definition status page to verify that the test store is in fact empty. At this point the computer displays a prompt to press CONTINUE, which reloads the RVC test store from the data file on cassette and verifies this by redisplaying the status page.

HP9835

```
1   ! FILENAME "TSTSAV"
2   ! THIS PROGRAM SAVES THE CONTENTS OF THE RVC TEST STORE IN Z$
3   ! THE STORE IS THEN ERASED. WHEN CONTINUE IS PRESSED THE DATA
4   ! IS RELOADED INTO THE RVC AND THE STATUS PAGE DISPLAYED TO
    VERIFY
10  DIM Z$[2100]
11  DISP "SAVING TEST STORE"
12  ASSIGN #1 TO "binary"
20  OUTPUT 700; "TO"
30  ENTER 701 BFHS 2048 NOFORMAT; Z$
35  PRINT #1; Z$
38  READ #1,1                   ! REPOSITION POINTER TO START OF RECORD #1
40  OUTPUT 700; "TS,2,KB"       ! CLEAR ALL TESTS IN 1210 TEST STORE
41  OUTPUT 700; "SS,3"          ! SELECT STATUS, TEST DEF. DISPLAY
50  DISP "PRESS "CONTINUE" TO RELOAD TEST STORE"
55  PAUSE
56  DISP ""
60  OUTPUT 700; "T1"
65  READ #1; Z$
70  OUTPUT 701 BFHS NOFORMAT; Z$
71  DISP "TEST STORE RELOADED"
100 END
```

HP85

```
  5 ! FILENAME "TSTSAV"
 10 ! TEST PROGRAM FOR "TO" AND "TI" COMMANDS
 12 ! SAVES THE DATA IN FILE "binary", THEN CLEARS TEST STORE USING
    "TS" COMMAND
 13 ! WHEN CONTINUE IS PRESSED THE STORE IS RELOADED VERIFIED BY
    THE DISPLAY OF STATUS PAGE
 20 ! SAVES DATA IN FILE "binary"
 30 DIM Z$[2100]
 40 IO BUFFER Z$
 45 ASSIGN# 1 TO "binary"
 47 OUTPUT 700; "SS,3" ! SELECT STATUS PAGE
 50 OUTPUT 700; "TO"
 60 TRANSFER 701 TO Z$ FHS; COUNT 1024
```

```
 90 PRINT# 1; Z$
100 ASSIGN# 1 to *
110 ASSIGN# 1 TO "binary"
160 OUTPUT 700; "TS,2,KB"
170 DISP "PRESS CONT TO RELOAD TEST STORE"
175 PAUSE
180 DISP ""
190 OUTPUT 700; "TI"
200 READ# 1; Z$
210 TRANSFER Z$ TO 701 FHS
215 DISP "TEST STORE RELOADED"
220 ASSIGN# 1 TO *
230 END
```

5.10.2 Reading Data from the RVC in ASCII Format

The following program, ASCOUT, reads data from the MAIN (display) buffer, stores it in an array 'A', and displays each value as it is obtained. In this particlar example the MAIN (display) function chosen is demand psd, (MN4).

HP9835

```
  1 ! FILENAME "ASCOUT"
  2 ! DEM PROGRAM FOR ASCII OUTPUT FROM RVC
  3 ! OUTPUTS AND DISPLAYS MAIN FUNCTION DATA
  4 ! DATA IS SAVED IN "ascdat", WHICH MUST BE CREATED PRIOR TO
    EXECUTION
 10 OUTPUT 700; "OF2,10" !DELIMITS OUTPUT CHARACTERS FROM RVC
                         WITH CRLF
 20 OUTPUT 700; "MN4"    !SELECT DEMAND PSD
 30 DIM A(501)
 35 OUTPUT 700; "MF1,2"  !OUTPUT FROM MAIN BUFFER IN ASCII
 40 FOR N=1 TO 501
 50 ENTER 700; A(N)
 60 DISP A(N)
 70 NEXT N
 80 ASSIGN #1 TO "ascdat"
 90 PRINT #1; A(*)
100 END
```

HP85

```
  1 ! FILENAME "ASCOUT"
  2 ! DEM PROGRAM FOR ASCII OUTPUT FROM RVC
  3 ! OUTPUTS AND DISPLAYS MAIN FUNCTION DATA
 10 DIM A(501)
 20 OUTPUT 700; "OF2,10"      ! SET DELIMITERS IN RVC
 30 OUTPUT 700; "MN4"         ! SELECT DEMAND PSD FOR OUTPUT
 40 OUTPUT 700; "MF1,2"       ! OUTPUT FROM MAIN BUFFER IN ASCII
 50 FOR N=1 TO 501
 60 ENTER 700; A(N)
 70 PRINT A(N)
 80 NEXT N
100 END
```

5.10.3 Writing Data to the RVC in ASCII Format

The following example program, ASCIN, shows how data may be written to the RVC, in ASCII format. ASCIN generates 501 data points of the function y = sinx/x. This data is then input to the RVC user buffer (UD) and subsequently displayed using the MN19 command.

HP9835

```
  1 ! FILENAME "ASCIN"
  2 ! DEM PROGRAM FOR ASCII INPUT TO RVC
  3 ! GENERATE A SPECTRUM, INPUT TO RVC USING UD COMMAND
  4 ! DISPLAY INPUT DATA USING MN19
 10 DIM A[501]
 11 DISP "CLEARING EXISTING SPECTRUM"
 12 OUTPUT 700; "UD1,1,1"       !ASCII INPUT TO USER BUFFER
 13 FOR N=1 TO 501
 14 OUTPUT 700; "O"
 15 NEXT N
 16 OUTPUT 700; "MN19"          !DISPLAY CLEARED
 20 M=0
 21 DISP "CALCULATING SPECTRUM"
 30 FOR N=1 TO 501
 40 B=SIN(6*PI*N/501)/(6*PI*N/501)
 50 B=ABS(B)
 60 A(N)=B
 65 IF N=200 THEN DISP "DONT WORRY, I'M WORKING ON IT"
 70 IF B>M THEN M=B             !RECORD MAXIMUM VALUE, M
 90 NEXT N
100 OUTPUT 700; "UD1,1,"; M
105 DISP "TRANSFERRING DATA TO RVC"
110 FOR N=1 to 501
120 OUTPUT 700 USING 121; A(N)
121 IMAGE D DDDDD
125 PRINT USING 126; A(N)
126 IMAGE #,8(SD.DDDDDXX)
130 NEXT N
135 DISP "TRANSFER COMPLETE"
140 OUTPUT 700 "MN19"          !DISPLAY NEW FUNCTION
150 END
```

HP85

```
  1 ! FILENAME "ASCIN"
  2 ! DEM PROGRAM FOR ASCII INPUT TO RVC
  3 ! SPECTRUM IS GENERATED AND INPUT TO RVC USING "UD" COMMAND
  4 ! THE GENERATED SPECTRUM IS THEN DISPLAYED USING "MN19"
 10 DIM A(501)
 20 DISP "CLEARING EXISTING SPECTRUM"
 30 OUTPUT 700; "UD1,1,1"
 40 FOR N=1 TO 501
 50 OUTPUT 700; "O"
 60 NEXT N
 70 OUTPUT 700; "MN19"
 75
 80 M=0
 90 DISP "CALCULATING SPECTRUM"
100 FOR N=1 TO 501              ! CALCULATE SINX/X FUNCTION
```

```
110 B=SIN(6*PI*N/501)/(6*PI*N/501)
120 B=ABS(B)
130 A(N)=B
140 IF M=200 THEN DISP "DONT WORRY, I'M WORKING ON IT"
150 IF B>M THEN M=B
160 NEXT N
170 OUTPUT 700; "UD1,1",M
180 DISP "TRANSFERRING DATA TO RVC"
190 FOR N=1 TO 501
200 OUTPUT 700 USING 210; A(N)
210 IMAG D DDDDD
230 NEXT N
240 DISP "TRANSFER COMPLETE"
250 OUTPUT 700; "MN19"
260 END
```

5.10.4 Reading Data from the RVC in Binary Format

The example program, BINOUT, given below shows how binary data may be read from the RVC. BINOUT simply copies the contents of the RVC Demand buffer (MN4) to the data file 'bindat' on tape.

HP9835

```
  1 ! FILENAME "BINOUT"
  3 ! DEM PROGRAM FOR BINARY OUTPUT FROM RVC, USING FAST
    HANDSHAKE (BYTE)
  4 ! SELECTED FUNCTION IS DEMAND PSD (MN4)
  5 ! A DATA FILE, "bindat", MUST BE CREATED PRIOR TO EXECUTION .
 10 DIM Z$[2100]
 12 ASSIGN #1 TO "bindat"
 13 OUTPUT 700; "MN4"
 20 OUTPUT 700; "MF2,2"
 30 ENTER 701 BFHS 2006 NOFORMAT; Z$
 35 PRINT #1; Z$
 38 READ #1,1                ! REPOSITION POINTER TO START OF RECORD
                             #1
 55 PAUSE
100 END
```

HP85

```
  1 ! FILENAME "BINOUT"
  2 ! DEM PROGRAM FOR BINARY OUTPUT FROM RVC, USING FAST
    HANDSHAKE
  3 ! SELECTED FUNCTION IS DEMAND PSD "MN4"
  4 ! DATA IS SAVED IN "bindat" WHICH MUST BE CREATED PRIOR TO
    EXECUTION
 10 DIM Z$[2100]
 20 IO BUFFER Z$
 30 ASSIGN# 1 TO "bindat"
 40 OUTPUT 700; "MN4" ! SELECT DEMAND PSD
 50 OUTPUT 700; "MF2,2"
 60 TRANSFER 701 TO Z$ FHS; COUNT 1003
 70 PRINT# 1; Z$
 80 ASSIGN# 1 TO *
100 END
```

5.10.5 Writing Data to the RVC in Binary Format

The example program, BININ, given below shows how binary data may be written to the RVC. BININ reads the data stored in a file 'bindat' on tape and writes it to the RVC user buffer. As in the ASCII examples, an MN 19 command is then used to present the data on the RVC display.

HP9835

```
  1 ! FILENAME "BININ"
  2 ! DEM PROGRAM FOR BINARY INPUT TO RVC
  3 ! DATA IS READ FROM "bindat" WHICH EXIST PRIOR TO EXECUTION
 10 DIM Z$[2100]
 12 ASSIGN #1 TO "bindat"
 20 READ #1; Z$
 25 OUTPUT 700; "UD2,1"          !WRITE BINARY DATA TO RVC USER BUFFER
 30 OUTPUT 701 BFHS NOFORMAT; Z$
 50 OUTPUT 700; "MN19"           !DISPLAY USER BUFFER DATA
 60 END
```

HP85

```
  1 ! FILENAME "BININ"
  2 ! DEM PROGRAM FOR BINARY INPUT TO RVC, USING FAST HANDSHAKE
  4 ! DATA IS READ FROM "bindat" WHICH MUST BE CREATED PRIOR TO
    EXECUTION
 10 DIM Z$[2100]
 20 IO BUFFER Z$
 30 ASSIGN# 1 TO "bindat"
 50 OUTPUT 700; "UD2,1" !WRITE DATA TO RVC USER BUFFER
 55 READ# 1; Z$
 60 TRANSFER Z$ TO 701 FHS
 90 OUTPUT 700; "MN19"           !DISPLAY USER BUFFER DATA
 95 ASSIGN# 1 TO *
100 END
```

5.10.6 Conversion of RVC Binary Data

The following program allows an HP85 computer to extract binary data from the RVC demand buffer and then converts the data into a format suitable for printing on the HP85 internal printer. Notice that the program branches after instruction 91; one branch (instructions 160–168) converts only the 16 most significant bits of the binary data, whilst the other branch (instructions 320–329) converts all 32 bits.

HP85

```
  1 ! FILENAME "BINCON"
  2 ! DEM PROGRAM FOR BINARY OUTPUT FROM RVC, USING FAST
    HANDSHAKE
  3 ! SELECTED FUNCTION IS DEMAND PSD "MN4"
  4 ! DATA IS SAVED IN "bindat" WHICH MUST BE CREATED PRIOR TO
    EXECUTION
  5 ! THE BINARY DATA IS THEN CONVERTED AND PRINTED
 10 DIM Z$[2100]
 15 DIM P[501]
 17 M=1
 20 IO BUFFER Z$
 30 ASSIGN# 1 TO "bindat"
```

```
 40 OUTPUT 700; "MN4" ! SELECT DEMAND PSD
 50 OUTPUT 700; "MF2,2"
 60 TRANSFER 701 TO Z$ FHS; COUNT 2006
 70 PRINT# 1; Z$
 80 ASSIGN# 1 TO *
 82 E=NUM(Z$[1])*256+NUM(Z$[2])    !CALCULATE EXPONENT FROM FIRST
                                   TWO BYTES
 85 F=2^(E-16384)
 90 FOR N=3 TO 2006 STEP 4
 91 C=0 !CLEAR MANTISSA SIGN CORRECTION VARIABLE
100 !FOR CONVERSION OF 16 MOST SIGNIFICANT BITS ONLY
101 !USE LINES 160-168
103 !FOR FULL 32 BIT RESOLUTION USE LINES 320-329

160 !TEST MOST SIGNIFICANT BIT OF MANTISSA FOR NEGATIVE
165 IF NUM (Z$[N]) > 127 THEN C = 256×256
167 !CREATE BINARY FRACTION * 2 ↑ EXP
168 P(M) = (NUM(Z$[N])*256+NUM(Z$[N+1])-C)/32768*F

320 !TEST MOST SIGNIFICANT BIT OF MANTISSA FOR NEGATIVE
325 IF NUM (Z$[N]) > 127 THEN C = 256×16777216
326 !CREATE BINARY FRACTION * 2 ↑ EXP
327 P(M) = NUM(Z$[N])*16777216+NUM(Z$[N+1])×65536
328 P(M) = P(M)+NUM(Z$[N+2])*256+NUM(Z$[N+3])
329 P(M) = (P(M)-C)/2147483600*F

390 !CONTINUE WITH COMMON PROGRAM
400 M = M+1
405 PRINT P(M)
410 NEXT N
420 BEEP
500 END
```

5.10.7 GPIB Plotter

The following example programs show how a GPIB plotter employing the HPGL graphics language may be commanded to plot a function displayed on the RVC.

The first program 'PLOT' sets the plotter XY limits, selects the function to be plotted (in this case demand psd with overlaid abort limits) and then proceeds to output the data. The end of the plot is detected by recognising the ASCII string "SP;IN" (select no pen and initialise plotter) in the output data.

The second example "PLOT2" uses the serial poll facility of the RVC. After setting the plotter limits and selecting the function to be plotted, the SV command is sent with argument 32, which sets the poll mask to interrupt on plot complete. The plot is then started, with the RVC set to Talk and the plotter set to Listen. On completion of the plot the message 'PLOT COMPLETE' is displayed on the HP85 monitor.

HP85

```
 1 ! FILENAME "PLOT"
 2 ! DEM PROGRAM FOR PLOTTER
 4 ! START BY SETTING PLOTTER PARAMETERS
10 DIM A$[100]
20 REMOTE 700
39
```

```
 40 OUTPUT 700; "PL,2,2,1" ! SELECT GPIB, ANNOTATION, A3
 50 OUTPUT 700; "PL,3,2,1500" ! SET PLOTTER XY LIMITS
 60 OUTPUT 700; "PL,3,3,7500"
 70 OUTPUT 700; "PL,3,4,6000"
 80 OUTPUT 700; "PL,3,5,10000"
 89
 90 OUTPUT 700; "MN4"                    ! PLOT DEMAND PSD
100 OUTPUT 700; "OV8" ! OVERLAY ABORT LIMITS
110 OUTPUT 700; "PL,1,2" ! START PLOT
119
120 ENTER 700; A$                        ! GET DATA FROM RVC
130 OUTPUT 703; A$                       ! OUTPUT TO PLOTTER
140 IF A$#"SP; IN" THEN 120              ! TEST FOR END OF PLOT
150 END
```

HP85

```
  1 ! FILENAME "PLOT2"
  2 ! DEM PROGRAM FOR PLOTTER
  3 ! USING PLOT COMPLETE INTERRUPT
  4 ! START BY SETTING PLOTTER
  5 ! PARAMETERS
 10 DIM A$[100]
 20 REMOTE 700
 30
 40 OUTPUT 700; "PL,2,2,1" ! SELECT GPIB, ANNOTATION, LIMITS
 50 OUTPUT 700; "PL,3,2,1500"
 60 OUTPUT 700; "PL,3,3,7500"
 70 OUTPUT 700; "PL,3,4,6000"
 80 OUTPUT 700; "PL,3,5,10000"
 90 OUTPUT 700; "MN4"
100 OUTPUT 700; "OV8"
104
105 S=SPOLL(700)  ! TEST BIT IN STATUS REG
109 ! START PLOT AND SET POLL MASK (32 for PLOT COMPLETE)
110 OUTPUT 700; "PL,1,2,SV32"
111 ! SEND EXTRA TERMINATORS TO OVERCOME MULTIPLE BUFFERING
    WITHIN RVC
112 OUTPUT 700
113 OUTPUT 700
119 ! SET RVC TO TALK, PLOTTER TO LISTEN
120 SEND 7; UNL TALK 0 LISTEN 3
125 RESUME 7
130 DISP "PLOTTING GRAPH"
136 ON INTR 7 GOTO 150
140 ENABLE INTR 7;8
145 ! WAIT FOR PLOT COMPLETE INTERRUPT
146 GOTO 146
150 DISP "PLOT COMPLETE"
160 END
```

5.11 COMMAND SYNTAX

5.11.1 Syntax Definition

See Section 5.11.3 for meaning of nomenclature.

<command> ≡ [<command code>[<number>][,<parameters>]*
<command delimiter>]*<message delimiter>

where

<command code> ≡ [<capital alpha>]*<two capital alpha characters>
<number> ≡ [<sign>]<digit>*[.<digit>*]
[E[<sign>][<digit>]*]

<parameter> ≡ [<specifier>]<number>
<specifier> ≡ KA/KB/KC/KD/KE/KF defines each of the last 6 possible parameters
<command delimiter> ≡ ;/<carriage return>/?
<message delimiter> ≡ <line feed>/<carriage return><line feed>
<any character and EOI>
(EOI is the GPIB message End or Identify)

Command functions not defined above:

BS(#08) acts as a character backspace, during numeric entry only.
DEL (#7F) acts as numeric entry clear
!"#$%&&()*/:=@ may replace the comma (,) as an argument delimiter.
>< GS(#2)FS(#3) are internal control characters and should not be used.
All other ASCII codes are ignored.

5.11.2 Numeric Format Definition

The following format applies to all ASCII numeric data that are output from the RVC.
See Section 5.11.3 for meaning of nomenclature.

<number> ≡ [△/–]<mantissa>[.<fraction>][E[+/–]<digit><digit>]

This shows the general form of the numeric data. The particular form depends on the range of the number, as follows:

(a) 1≤number≤99999999, floating point, i.e.
<number>≡[△/–]<mantissa>[.<fraction>]

(b) 1>number>99999999, fixed point i.e.
<number>≡[△/–]<mantissa>[.<fraction>]E[+/–]<digit><digit>
<mantissa> contains no leading 0's.
<fraction> contains no trailing 0's and blanks the '.' if zero.
The total number of digits in both the
<mantissa> and <fraction> is always less
than, or equal to, 8.
[<digit><digit>] - always contains a factor of 3 (engineering format)
and is in the range −99 to +99.

(c) 1E−99 >number > 1E +100, numeric range error
< number > ≡ $

5.11.3 Nomenclature for Syntax Definitions:

1. Descriptive items, e.g. < parameter >, are shown in lower case enclosed in brackets '<' and '>'
2. Alternative items are separated by the character '/'.
3. Optional items are enclosed in the brackets '[' and ']'.
4. Groups of items are shown enclosed in brackets '[' and ']'.
5. Items which may be repeated are followed by an asterisk '*'.
6. '≡' means "defined as".
7. '△' is equivalent to a space character.
8. All other characters appear as shown.
9. '#' preceding a number is used to indicate a hexadecimal number base.

Solartron Instruments

MP MASTER
MA20210

SOLARTRON
Schlumberger